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FEBRUARY, 1934.

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(*Article by* H. H. Curson, F.R.C.V.S.)

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FEBRUARY, 1934.

Editorial

WHAT ABOUT VETERINARY EDUCATION?

WE draw the attention of our readers to a very interesting article in this month's issue written under the above title by an American colleague, Dr. C. H. Stange, of the Iowa State College, U.S.A., and read before the Members of the American Veterinary Medical Association at Chicago in August last. Although it is intended to set forth the position and prospects of Veterinary Science in the United States, there is a very great deal of it which can be taken seriously to heart here in the veterinary world of Great Britain; for in many things, veterinary as well as lay, our two English-speaking races must work together, and the professional work of our colleagues in America has much in common with the work of the veterinary surgeon in this country.

Our colleague, Dr. Stange, asks in his initial paragraph: "What is to be the future field of Veterinary Medicine, and the coming status of the Veterinarian?" Quite correctly, he points out the revolutionary change which has taken place in the routine of the general practitioner owing to the "passing" of the horse, truly describing that "many of our problems to-day are of State, National and even International character; whereas formerly we were concerned largely with individuals"; and where in the ages past the private practitioners out-numbered all the other branches of veterinary science combined together, at the present time the pendulum appears to have swung the other way, and our younger graduates are in the main finding positions, Government or Municipal, with fixed rate of pay with allowances, and none of the expenses of a practice to find.

Dr. Stange discusses the insufficiency of qualified men, and the danger, if this is not speedily remedied, both to the Public Service and also to the profession itself. In regard to the Public Health Service, the author asks: "To what extent should the veterinary profession enter into public health work?" the question being followed by the statement that "there were a number of lines of work, many of them of an Institutional or Government nature, where non-professional men or members of other professions are holding positions which could be more efficiently served by men with a veterinary training"; and in commenting here, Dr. Stange very forcibly states that "although sometimes due to the fact that such fields have not seemed sufficiently attractive to graduates in veterinary medicine, in many cases the principal reason has been that the Colleges did not offer work which adequately prepared young men for such service." He then passes on to discuss the responsibility of the Veterinary College, and even goes so far as to assert definitely that "the future of the veterinary profession, both qualitatively and quantitatively, is in the hands of the Veterinary Colleges." In the number of these in America, there has been a reduction from twenty-three in 1916 to nine at the present time, the result being that fewer men have graduated; and that unless the number of graduates increases approximately 47 per cent. above the present year's figure "there will not be enough veterinary surgeons to carry out the veterinary duties which the country needs." Dr. Stange is, of course, speaking for the United States only, but the "writing is already on the wall" in this country too, and there is just as much a shortage of members of the profession at the present time in the British Isles as there is on the other side of the Atlantic. Whatever other differences they may have, American and British Veterinary Science are at one over this, whereas our Continental *confrères* are so overcrowded that they frequently write over here to try to find employment; whilst in Great Britain there is great difficulty to find qualified assistants, either male or female, at liberty.

Dr. Stange emphasises the value of the compulsory pupilage idea, and there can be no doubt as to its value. The Council of the R.C.V.S. has, in the new Syllabus for the Five Years' Course, already provided for this, and, moreover, it includes the paragraph: "and shall have seen at least six parturition cases in the larger animals." Little enough, but something! and an indication that the pupil must have been amongst farm animals for at least a minimum portion of his early professional career.

This addendum, small and insignificant as it appears amongst the other pronouncements of a lengthy and detailed syllabus, is one of the most important of any, and will do much towards giving the new graduate that touch of practice which his teachers at College have often been unable to persuade him to consider as an essential feature to the success of his future career; for, in veterinary practice in particular, one needs to learn how to gain the confidence of the client before one can even obtain the opportunity to see the patient; and the one is of no use without the other as a means of livelihood.

General Articles

THE INTERNAL PARASITES OF HORSES: A SURVEY.

By THOMAS W. M. CAMERON, M.A., Ph.D., D.Sc., M.R.C.V.S.

Research Professor of Parasitology, McGill University, Montreal; Director, The Institute of Parasitology, McGill University, Montreal.

NONE of our domesticated animals suffers more from internal parasites than does the horse; and he shares with sheep the unenviable distinction of being never entirely free from worms. The horse in his pre-domesticated days was a plains animal, probably originating on the Steppes of Asia. His parasites had become adapted to his special environment there, and had learned to resist the dry and unfavourable conditions of these grasslands. They are still among the most resistant of all the helminth parasites, although man has largely removed the need for resistance. Horses are now sheltered in warm, damp stables, and conditions for the free life of the parasites are made as favourable as possible. On the few occasions on which he is kept out, he is confined to a permanent pasture, and given every opportunity for becoming infested. Even were the equine parasites not specially resistant to adverse influences, horses would still be heavily parasitised. But when one considers that the infective larvæ of the innumerable red worms of the horse can blow about in the dust and live in this dried state for over a year, it will be readily realised why it is so exceptional to find a horse free from parasites, and so usual to find them really heavily infested. It is safe to say that internal parasites to-day constitute the greatest single source of loss to horse owners, and the greatest cause of inefficiency. The fact that this is not generally appreciated makes it even more important that veterinary surgeons should be in a position to recognise the common and usual parasites which affect horses, where they occur, how they can be eradicated, and how the owner can keep their numbers within reasonable limits. As in other stock animals, the parasites of horses are mainly included in four phyla: the protozoa, the flat worms, the roundworms, and the arthropods. While all the members of the first three groups found in equines are internal parasites, most of the last group are external. In it, however, is included one important genus of entozoa—the bots. The parasites in this survey are treated according to habitat rather than according to their zoological classification; more attention also is paid to forms found in Britain.

The stomach is a favourite site for parasites in the horse. The commonest forms found are the maggots of the bot-flies, at least three species of which are known to occur there. The only one common in Britain, however, is *Gastrophilus intestinalis*. It is doubtful if it does any real harm. The bots are of a reddish colour, and occur almost entirely on or at the margin of the œsophageal lining

of the stomach. In due course, they pass to the exterior with the droppings, pupate, and give rise to the adult flies. As a rule the eggs of this species are laid on the legs of the horse. The other two species are comparatively rare. One—*G. nasalis*—which deposits its eggs under the jaw of the horse, in this way causing it some considerable annoyance, has yellowish bots, which are attached to the true gastric and the duodenal mucosa. The other—*G. hæmorrhoidalis*—deposits its eggs on the lips, thus annoying the animal even more than the previous form. The bots of this species, in addition to occurring in the stomach and duodenum, are found in the rectum. The location of these two species makes them much more dangerous than the common bot, and they are a frequent cause of colic. Both are scarce in Britain, but they are spreading in Canada, and so becoming increasingly important. Carbon disulphate still appears to be the most satisfactory drug for their removal.

Of the three species of *Harbronema* known to occur in the stomach of equines in all parts of the world, only one—*H. microstoma*—is known to be present in Britain, and it is not common. This is a slender worm, under an inch in length, which is found lying on the surface of the gastric mucosa. It is credited with causing a chronic gastritis, but the parasite is so common in warm countries—practically every horse in Egypt, for example, is infected—that the pathogenicity must be slight. One of the other species, however, *H. megastoma*, lives in large fibrous tumours on the stomach wall, the lesion often reaching the size of a hen's egg, or even larger. All three species are carried by flies, generally house or stable flies, the infection being picked up from the manure.

One generally overlooked parasite of the true stomach is *Trichostrongylus axei*, a form which Leroux, in 1924, showed was the same as *T. extenuatus* of sheep. Since then, however, other species of *Trichostrongylus* have been found in equines. In this host they cause an inflammatory lesion which may superficially resemble ring-worm, or which may be quite diffuse.

The most important parasite in the intestine is the round-worm—*Ascaris equorum*—a parasite which is quite universal in its distribution, and which, although a large one, often occurs in enormous numbers. It appears to do little damage in its adult state, but as its life cycle is almost identical with that of *Ascaris lumbricoides* of the pig, it has very serious effects on young and growing horses. Treatment for the adult form is easy, although useless for the larval stage during its migrations through the liver and the lung. Accordingly, in all well-regulated stables steps should be taken to prevent infection in young animals on lines very similar to those adopted in the sanitary system for pigs.

This is the only round-worm in the small intestine of the horse; but in various parts of the world two species of tapeworms are found in this location. One, *Anophocephala magna*, is large and massive, and although it occurs in Canada and other temperate parts of the world, it has never been recorded from Britain. The other, *A. mamillana*, is small and easily overlooked, but is by no means uncommon in Britain. It appears to be quite harmless however, unlike the third

species of equine tapeworm which occurs in the large intestine. This species, *A. perfoliata* by name, is quite common in all parts of the world. It is distinguished by large suckers which cause an ulcer-like lesion in the mucosa of the large intestine. Their presence can often be diagnosed by the appearance of fresh blood on the surface of the formed fæces.

The trematodes of the horse are few in number, and, like *A. perfoliata*, they live mostly in the large intestine. The commonest and most important is the peculiar *Gastrodiscus ægyptiacus*, an amphistome fluke with a flat body and a conical anterior end, which is common throughout Africa and parts of Asia, but which is absent from colder climates. A related fluke, *Pseudodiscus collinsii*, is commonly found in horses in India, but has recently been recorded for the first time in Egypt by Major Slocock.

The most important of all the metazoan parasites of horses is the group of bursate nematodes called *Sclerostomes*. This group includes several different genera, and a large number of species. Some of these are small and uncommon, others are large and important. The first of the important genera is *Strongylus*, with its three species in the horse. *S. vulgaris* is the smallest species, and is responsible for the very common parasitic aneurisms. *S. edentatus* is larger and more common, while *S. equinus* is the least common of all, at least so far as Britain is concerned. It was once believed that the parasitic aneurisms were part of the normal life cycle of *S. vulgaris*, but recent work suggests that they are really accidental. The infective larva of the worm, swallowed with the fodder, penetrates the gut wall and reaches the blood stream. It does not stop there, however, but, passing up the portal vein to the liver, it ultimately reaches the lungs and returns to the intestine in the same way as does *Ascaris*. During this journey some larvæ get side-tracked, and in attempting to complete their development in the mesenteric vessels, they cause the production of aneurisms. The other two species have a similar type of life cycle, but such of their larvæ as lose their way pass to various parts of the body ; in the case of *S. edentatus*, the larvæ are very commonly found in little nodules below the peritoneum.

The second genus, *Triodontophorus*, is unimportant in its larval stage, but is interesting not only because its adult stage is a blood sucker, but because one species (*T. tenuicollis*) prefers to feed on the course of the dorsal cœlic artery in the right dorsal colon. Here the nematodes will be found literally in hundreds, with their heads buried in the ulcer which they have caused and with their bodies projecting like the quills of a porcupine. The life cycle of this genus does not seem to involve any migration. In the case of the genus *Trichonema* (a name which includes the old term *Cylicostomum*) a modified migration appears to take place, the larvæ emigrating only as far as the mucosa or submucosa to encyst there until the times comes for their return to the lumen of the intestine. Although all the members of this genus are small worms, they vary in size ; the larger develop in the sub-mucosal cysts, while the small actually develop in the mucosa itself. These cysts are often so numerous that it is almost impossible to stick

a pin into the mucous membrane without touching one of them. The habits of the adults vary considerably: some are blood suckers, while others feed on the intestinal contents, including ciliates and even other nematodes. Removal of the adults is again easy, but the larvæ are still resistant to all our efforts. Fortunately, in the case of many stables control can be easily carried out by means of proper manure disposal and periodical dosing of adult animals. The use of manure hot-boxes, or the addition of chemicals to the manure, will kill the developing free-living larvæ. In this connection it is of interest to note that my colleague, Dr. I. W. Parnell, has been able to demonstrate that the most convenient lethal chemical to add to manure is ordinary horse urine. This not only is sound agricultural practice in increasing the fertilising value of the manure by the addition of material which costs nothing and is often wasted, but it kills both the eggs and the larvæ of the sclerostomes in a remarkably short time. (These experiments and their application to practice are in course of publication.)

The final parasite of importance in the large intestine is *Oxyuris equi*, a small white pinworm found wherever horses occur. The final larval stages of this worm are blood suckers, although the activities of the adults are confined to reproduction, and they appear to feed on the intestinal contents. The gravid female causes considerable local irritation when she emerges from the perineal surface to lay her eggs.

Although *Fasciola* is occasionally seen in the liver, it is an uncommon parasite in horses. The commonest helminth in this site is the *Hydatid cyst*, and it is very much more common in horses in Britain than would be suspected. It is usually small and simple, and unless a post-mortem examination is carried out its presence is almost always unsuspected. Yet it has been recorded as occurring in 40 per cent. of horses killed in London. The lungs also are usually free from parasites, but one of the husk worms, *Dictyocaulus arnfeldi*, is occasionally found there. This species is commoner in donkeys than in horses, however; its results and treatment follow lines similar to that noted for husk in sheep. In the body cavity of horses in many parts of the world occurs a largish filaria worm called *Setaria equina*. It is common in Canada and elsewhere, but it has only once been found in England, and that recently by Mr. Leroux (who has given me permission to add his unpublished finding to my records). It is doubtful if this parasite causes any damage, although it may provoke a small local patch of chronic peritonitis.

Several other filaria worms occur in horses. One, *Onchocerca cervicalis*, is probably very common, although it has only been recorded from the United Kingdom and Canada very recently. It occurs in the ligamentum nuchæ, and may have some causal relationship with poll evil. This, however, has yet to be proved. A related form, *O. reticulata*, is found in other ligaments in horses on the Continent, but it has not yet been recorded from British horses. In the Near East, in subcutaneous situation, is found another filaria worm called *Parafilaria multipapillosa*, which is credited with provoking metastatic subcutaneous swellings, and so interfering with the harness. It also is absent from Britain. In the blood

vessels, especially in Asia, occur various bilharzia worms, where they have been found to be a common cause of cirrhosis and debility, but the most important blood parasites are the protozoan genera, *Trypanosoma* and *Babesia*. None occur in Britain.

All three important Tsetse transmitted trypanosomes in Africa—*T. brucei*, *T. vivax* and *T. congolense*—cause disease in the horse as well as in ruminants. *T. brucei* is very pathogenic to equines, killing them in a period varying from two weeks to three months ; *T. vivax* and *T. congolense* are much more chronic.

Trypanosoma evansi, in India and neighbouring parts of Asia, causes the almost invariably fatal disease called Surra in equines. Treatment is difficult, and only a small proportion of animals recover ; Bayer 205 has been the most successful. It is carried by biting flies. What is probably the same parasite is found in South America under the name of *T. equinum*, causing Mal de Caderas ; the method of transmission is probably similar to the Indian species, but one strain of *T. evansi* (*T. hippicum*) can be transmitted by vampire bats in Central America.

In temperate climates the important *T. equiperdum*, the cause of dourine, has an almost universal distribution. This form is peculiar in that it has lost the need for a blood-sucking vector, and is now almost exclusively transmitted by coitus. Only equines are infected naturally, and the disease is chronic and amost always fatal. It has fortunately never been established in Great Britain, but elsewhere it causes great loss. Its insidious course made it extremely difficult to eradicate until Watson, in Canada, elaborated a complement fixation test by the use of which the disease was eradicated from the Dominion.

Two species of *Babesia* occur in equines, a small form, *B. equi*, and a larger one, *B. caballi*. Neither occur in Britain or North America, although elsewhere they are widely distributed. The latter is believed to cause a less severe disease, but both have been so confused in the past that clinical differentiation is not reliable. Both are tick transmitted.

General.

This survey is not by any means exhaustive, and mention has been made of only the commoner or more important of the internal parasites of equines. Some of these are easily amenable to anthelmintic treatment, although search is still being made for safer and more efficient drugs. As in the case of other animals, treatment is essentially the duty of the veterinarian. No one else can properly appreciate the possible effects of a poisonous drug on a sick animal, and yet anthelmintics are still bought and sold, used and abused, by all and sundry.

Prevention is, however, the duty of the horse owner, and much can be done to reduce infections from internal parasites in horses. Dipping for ticks and control of flies are two essential steps to be taken in the case of blood parasites, while manure control is the key to the prevention of the very important intestinal worms. All the measures usually recommended for pigs and sheep can be usefully

adapted to horses, while additional ones are available. Sanitary stables, clean drying standings, raised feed boxes, hay racks and water troughs, prompt removal of manure and treatment with heat, urine or chemicals before spreading, are all measures to be adopted. But horse parasites are even more resistant and difficult to control than those of other animals ; even the Army, with its efficient hygiene and discipline, finds them difficult to keep in check by purely preventive means. Accordingly, periodical dosing is still one of our best preventive measures.

THE EFFECT OF AN IODINE SUPPLEMENT IN THE RATION OF DAIRY COWS.

By W. THOMSON.

Rowett Research Institute, Aberdeen.

NUMEROUS studies have been made regarding the effect of iodine on milk yield. Summaries of Continental work, notably that of Niklas, Strobel, Scharrer and Schropp, in Southern Germany, of Weizer and Zaitschek in Hungary, and of von Wendt, in Finland, have been made by Orr and Leitch[1,2]. As all the observations referred to were made over comparatively short experimental periods, it is impossible to judge whether the variations in yield, interpreted in some cases as beneficial effects of iodine, are really due to iodine or are merely variations that take place normally in the course of a lactation.

In the course of recent investigations, primarily designed to determine the effect of iodine on a specific aspect of metabolism such as milk yield, evidence has emerged indicating that iodine may also influence the susceptibility of the experimental animals to disease. Thus, where iodine with or without other minerals, has been used, favourable effects on the course of abortion and sterility have been noticed. Stiner[3]and Schropp[4] have both found that administration of iodine, either as an inorganic salt or in pasture manured with iodine, had a beneficial effect on fertility, the number of services required being reduced. Müller-Lenhartz and v. Wendt[5] found similar results to follow the feeding of a mineral mixture containing calcium, phosphorus, iron and iodine. Mackie,[6] in an area in Scotland, has been carrying out systematic treatment of herds suffering from contagious abortion with the oral administration of potassium iodide, and has achieved what are apparently excellent results. On the other hand, Forbes[7] and his co-workers found that the administration of iodine did not affect the course of abortion disease as indicated by results of the agglutination blood test.

In order to gain further information on these points, an experiment was conducted continuously over five complete lactations to ascertain whether iodine imposed on a good ration exercised any effect on the general health, reproductive capacity and milk yield of dairy cows. The animals used were non-pedigree

Aryshires, fifteen first-calf heifers, two second-calf cows, and one third-calf cow, divided into two uniform groups of nine cows each. To the ration of one group ninety milligrams of iodine per head per day was added in the form of a solution of potassium iodide. The other group acted as a control, and got no supplementary iodine. The basal ration was well balanced, and was composed of foodstuffs in common use, those known to be unusually high in iodine being excluded. No fresh green food was fed. The cows were house-fed throughout the entire period of sixty months over which the trial was conducted. Outdoor exercise was given daily in small bare paddocks, each group being kept separate. The results of the experiment are noted below.

General Health.—Throughout the experiment the general health of both groups was remarkably good, but it is worthy of note that the iodine group invariably exhibited a healthier and more sleek appearance than the control group.

Reproduction.—Examination at the outset of the experiment showed that all the non-iodine cows were negative to the abortion test, while three of the iodine group gave a positive reaction. Nevertheless, three of the non-iodine cows aborted during the first pregnancy, and one had a premature calf which died. Only five normal calves were got from the nine non-iodine cows. On the other hand, all the iodine-fed animals produced normal calves. During the second pregnancy there occurred one abortion and one still-birth in the non-iodine group, and one abortion in the iodine group. In subsequent pregnancies all cows in both groups, with the three exceptions noted below, produced normal calves. In the iodine group one cow proved sterile after the second lactation, while another was slaughtered following milk fever and complications, and in the non-iodine group one proved sterile after the third lactation.

Milk Yield.—In dealing with the milk yields, only those cows which completed the whole five lactations are considered, *viz.*, eight in the non-iodine and seven in the iodine group.

In Table I, figures are given for both groups, showing the average yield per cow in gallons in each lactation, together with the percentage increases or decreases between successive lactations.

TABLE I.

NON-IODINE GROUP.

Lactation	1st	2nd	3rd	4th	5th
Average yield per cow (galls.)	748.98	688.86	868.55	816.53	819.06
Increase or decrease:					
Successive lactations compared	—	−8%	+26%	−5.9%	+0.3%
3rd and 1st ,, ,,	—	—	+15.9%	—	—
4th and 1st ,, ,,	—	—	—	+9%	—
5th and 1st ,, ,,	—	—	—	—	+9.3%

IODINE GROUP.

Lactation	1st	2nd	3rd	4th	5th
Average yield per cow (galls.)	626.14	713.20	773.33	793.94	828.78
Increase or decrease:					
Successive lactations compared	—	+13.9%	+8.4%	+2.6%	+4.3%
3rd and 1st ,, ,,	—	—	+23.5%	—	—
4th and 1st ,, ,,	—	—	—	+26.8%	—
5th and 1st ,, ,,	—	—	—	—	+32.3%

In Table II, corresponding data are given for the milk yield per cow per day from calving to calving. This method of representing the results is probably more legitimate than that adopted in Table I, inasmuch as it takes into account the dry periods, of varying length, over which the cows have to be maintained without return in the form of milk.

TABLE II.

NON-IODINE GROUP.

Lactation:	1st	2nd	3rd	4th	5th
Av. yield per cow per day (lb.)	19.48	17.82	23.55	21.72	20.6
Increase or decrease:					
Successive years compared ...	—	−8.5%	+32.1%	−7.7%	−5.1%
3rd and 1st ,, ,, ...	—	—	+20.9%	—	—
4th and 1st ,, ,, ...	—	—	—	+11.5%	—
5th and 1st ,, ,, ...	—	—	—	—	+5.7%

IODINE GROUP.

Lactation:	1st	2nd	3rd	4th	5th
Av. yield per cow per day (lb.)	15.48	18.15	20.90	21.84	20.60
Increase or decrease:					
Successive years compared ...	—	+17.2%	+15.1%	+4.4%	−5.6%
3rd and 1st ,, ,, ...	—	—	+35%	—	—
4th and 1st ,, ,, ...	—	—	—	+41.0%	—
5th and 1st ,, ,, ...	—	—	—	—	+33%

The figures in Table II have been subjected to statistical examination, showing that, considering the number of cows used, this result could occur at random once in every ten or eleven trials.

The conclusion from this trial is that when tested over a long period the daily addition to the ration of a small amount of iodine seems to assist in maintaining the general health and, as a probable result of this, the milk-yielding capacity of dairy cows. The low milk yield in the control group is probably due, at least in part, to the number of abortions that occurred in that group. The data on

contagious abortion are recorded as indicating a possible rôle of iodine in the prevention of this disease. The observations are too few to warrant any conclusions being drawn, but emphasise the necessity for undertaking additional work on an extended scale with a much larger number of animals. Practical trials conducted on 200 to 300 farms representative of different areas are advocated. By administering iodine to one-half of each herd maintained on such farms, and using the remainder as controls, the effect of iodine on contagious abortion could be tested under conditions sufficiently controlled to give valuable practical information.

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IMMUNISATION EXPERIMENTS AND VACCINE TREATMENT IN INFECTIOUS ABORTION.

By HALFDAN HOLTH.

Sartryck ur Skandinavisk Veterinartidskrift, 1933.

REFERENCE is made to some earlier experiments by the author, who showed that rats could be immunised with dead abortion bacilli and culture filtrate against subsequent artificial infection, and that immune sera could be produced. The author in this article describes some work on heifers kept at the institute. He experimented with the preparation of a killed vaccine, in the making of which he used antiformin or formalin, and he also worked with culture filtrates. He was unable to demonstrate that any immunity followed the use of any of the vaccines in guinea-pigs infected after vaccination. He prepared serum in rabbits and sheep by repeated injections of similar vaccines, but found little or no protective or curative effects in cases of infections with abortion in guinea-pigs. The next series of experiments consisted in the use of vaccines in guinea-pigs already infected with abortion bacilli, and he concluded from his results that both vaccines (antiformin and formalin) "exerted a very considerable effect on abortion," and that "the curative effects seem to bear some relation to the vaccine doses employed."

These results led to experiments on heifers. Antiformin-treated vaccine was used in a preliminary experiment on one heifer. One dose injected before conception did not prevent abortion, but the injected heifer remained in comparative good health, while the control, non-vaccinated, animal showed much general disturbance following infection with virulent culture. Four heifers were next used. One

was kept as a control, one was treated with culture filtrate, and the other two with antiformin vaccine. They received repeated doses during their pregnancy. The culture-filtrate did not prevent abortion, but the animal remained in good general health, while the control suffered considerably following the injection of virulent bacilli. Of the two injected with antiformin vaccine, one remained normal in every way, while the other, though not aborting, excreted bacilli from the vagina and udder. The author draws the following conclusion: "The experiment seems to show that vaccine treatment, carried out in the manner described, exerts a very palpable influence. Even if abortion infection cannot always be prevented, the curative effects of the vaccine will make themselves felt, and will in some degree check the development of pathological processes, and this will be manifested by a milder course of the disease with small disturbance of general health."

TUMOUR SURGERY AND LOCAL ANÆSTHESIA.

By W. R. McKINNA, M.R.C.V.S., D.V.S.M.
Huddersfield.

THE ease of application and the numerous excellent local anæsthetics tend to make one use them in preference to general anæsthesia perhaps more often than the after results justify. For use over small areas, local anæsthetics are excellent in everyday surgical use, and cannot be discarded; but when used for infiltrating extensive areas, as are sometimes occupied by some tumours, one has been disappointed with the after healing of the wound, although the operation has been carried out under strict aseptic precautions and without pain.

We have noted that we have obtained much better healing of wounds after tumour removal has been undertaken under general anæsthesia, and now make it a practice to discard local anæsthetics when a large area is involved. In addition, those cases where a cavity is necessarily left after the removal of the growth heal with less trouble if a drainage tube is anchored in the most dependent part of the wound for several days. Such details of technique are probably generally practised by many surgeons; we have found their benefit in our own experience.

NORMAL AND ABNORMAL GIZZARDS.

By G. MAYALL, M.R.C.V.S.
Bolton.

THERE is little in poultry text-books on diseases of the gizzard in the fowl. Foreign bodies and inflammation of the organ receive due attention, but little else is mentioned. When one conducts a number of post-mortems a year one is struck by the variations one finds in the contents of the gizzard and in its consistency. There are times when one can only account for the death of the bird by the fact that the gizzard has failed to act physiologically and mechanically.

What are the characteristics of a healthy gizzard? It depends on the character of the food, the presence of sufficient room for the grit or pebbles to act, and the proper flow of digestive juices from the true stomach (proventriculus). The little stones in the gizzard lighten its mechanical action and also cause increased function of the gizzard by reflex irritation. It seems, therefore, in a healthy normal gizzard that there must always be a number of small pebbles. Cinders, by their rough surfaces and lack of triturating power, seem to be deleterious, and in some cases we have attributed death to them, by blocking up the gizzard and not passing on. Sharp pieces of glass also seem to be injurious. Unclipped oats often cause the end of not a few fowls, and we have found death to be due to impaction of the crop and gizzard from this grain, especially when the fowls also take up a lot of fibrous grass. Recently, probably owing to lack of water, we have come across gizzards absolutely packed with black dirt, and not a vestige of food in them. This is probably derived from the bottom of partly dried mud puddles, or drying-up ponds. In these cases one may find the crop full of food, but not a particle of it passing down the œsophagus into the gizzard, and as a result pneumonia and heart disease. Whole maize has a bad effect, and we have seen cases where crop and gizzard have been put quite out of action by the use of this corn. Wheat, dari, middlings and Sussex ground oats seem to be about the best staple foods for poultry. We have found foreign bodies on several occasions in the gizzard; examples being nails, staples, pieces of wire, and on one occasion the needle of a hypodermic syringe. Curiously enough, we have hardly seen any cases that we might describe as pure and true inflammation of the gizzard, and we do not think it often happens. On a few occasions we have, however, encountered inflammation of the proventriculus.

"CRIPPLES" IN LAMBS.—I.

By S. E. PIERCY, B.Sc.

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Introduction.

As a result of the general inquiry by Stewart[1] into the disease known as "cripples" which occurs on many Northumbrian sheep farms, it was decided to undertake detailed experiments in the hope of ascertaining the cause of the disease, or at least of eliminating certain factors which might be held responsible. This disease occurs in lambs generally from seven to fourteen days' old, and is manifested by stilted gait, difficulty in rising, inability to flex joints and by an abnormal fragility of long bones and ribs, frequently leading to partial and complete fractures.

Elliot and Chrichton[2] have shown that "bent leg," a rachitic disease occurring not only in sheep fed on concentrates, but also in sheep running free on pastures, is probably a deficiency disease, and can be prevented by adding mineral salts to the diet. In the summary of his monograph on "Minerals in Pastures," Orr[3]

writes: "In cases of extreme poverty, lack of one or other of the minerals may be the cause of disease in the grazing animal." Godden[4] has demonstrated that many of the hill pastures in England and Scotland are relatively low in certain important mineral elements, while Shearer and Stewart[5] state that the calcium content of the blood of sheep on many Northumbrian hill farms is below normal as a result of the deficient nature of the pastures. Stewart[1] suggests that the dominant symptom of the disease, *i.e.*, abnormal fragility of long bones and ribs, is probably related to imperfect osteogenesis, causing the formation of a type of bone deficient in quantity and/or abnormal in character, and states: "There is a certain amount of evidence tending to support the view that 'cripples' may be an indirect manifestation of mineral depletion of the soil." In many respects, therefore, the whole picture of the disease appeared to fall in line with a mineral deficiency hypothesis, and accordingly it was decided to test this by feeding minerals direct to a number of ewes on a typical "cripples" farm.

Experimental Details.

(1) *The Farm.*—A typical Northumbrian hill farm was chosen, comprising some 2,300 acres, 2,000 of which is high land of low nutritive value on which "cripples" has never been known. The remaining acreage is lower lying, and consists of old pastures growing on heavy land. This latter area carries about 220 Cheviot ewes, which are crossed with the Border Leicester ram to produce half-bred lambs which are sold in the autumn. In this flock "cripples" has abounded for at least eight years.

(2) *The Sheep Used.*—From the above flock 100 ewes were divided off at random for the purpose of receiving a special feed. Ten representative ewes were shed from this lot and tatooed on the inside of the ear. Similarly ten ewes were shed and tatooed from the remainder of the flock, which were not to be specially fed. These two batches of ten sheep were used throughout the experiment to compare the blood pictures of the fed and unfed lots.

(3) *The Feed Used.*—A cake was specially prepared designed to show a good analysis of protein, carbohydrate and oil, with an abundance of all important minerals, together with cod-liver oil.

Analysis of Special Cake.

	Per cent.
Moisture	9.55
Oil (*a*)	4.75
Albuminous compounds (*b*)	23.27
Carbohydrates	39.21
Woody fibre	4.4
Ash (*c*)	18.82
Total	100.09

(*a*) Containing Cod-liver oil, 2.00 per cent. (*b*) Containing nitrogen, 3.724 per cent. (*c*) Including silicious matter, 0.50 per cent.

MINERAL COMPOSITION OF CAKE.

Bone flour	12 per cent.
Powdered chalk	5 per cent.
Common salt	4 per cent.
Red iron oxide	0.2 per cent.
Copper sulphate	2 grams per 100 lb. cake
Manganese sulphate	1 gram per 100 lb. cake
Potassium iodide	a trace

Of the total ash content, 4.08 per cent. was originally contained in the cake, and 14.74 per cent. was added.

(4) *Technique.*—All blood samples were taken from the jugular vein, and the blood collected into (*a*) a centrifuge tube in which it was allowed to clot for serum calcium estimation, and (*b*) a small bottle containing sufficient potassium oxalate to prevent coagulation in accordance with the technique recommended by Auchinachie and Fraser[6] for the collection of blood samples in the field. The method followed for the estimation of serum calcium was that of Kramer and Tisdall,[7] and for inorganic phosphorus a micro-adaptation of Brigg's modification of the Bell Doisy technique.[8] For the estimation of hæmoglobin, a Newcomer standard disc was used. In the literature on human blood various figures are given as normal percentages of hæmoglobin (expressed in "grams per cent.," *i.e.*, grams per 100 c.c. of blood), such as 13.8 (Haldane), 16.9 (Williamson), and 15.6 (Haden).[9] Sheep's blood, however, contains relatively less hæmoglobin, and in order to be able to detect deviations from normality it is necessary to know the normal absolute figures for sheep's blood, which may be expressed as a normal standard. Accordingly, 100 samples of blood were obtained: fifty by bleeding sound sheep from a commercial flock within the county, and fifty by collecting blood at the slaughter-house. The average figures obtained were 10.95 grams per cent. and 11.94 grams per cent. respectively. The average for the 100 sheep was 11.45 grams per cent., and this figure was taken as representing the normal amount of hæmoglobin in sheep's blood. By setting this figure equal to 100, abnormal sheep's blood can be shown on a scale reflecting percentage variations from the normal.

The Experiment Described.

On January 18th, 1933, an initial analysis of the blood of the twenty sheep representing the two lots, fed and unfed, was made, and their body weights recorded (Table I). Feeding with the special cake was commenced the following day.

The average figures for the whole 20, that is Ca. 9.04 mg. p.c., P. 4.48 mg. p.c., Hb 10.21 gm. p.c., show that the animals were normal as regards these constituents of the blood, although some of the individual figures probably approach the lower physiological limits. For example, Stewart and Shearer[5] give as the average for 100 ewes at Cambridge the figures Ca. 10.0–11.0 mg. p.c., P. 4.5–6.0 mg. p.c. In several cases figures distinctly below normal were recorded,

notably in the case of the inorganic phosphorus (Table I, sheep Nos. 3, 8 and 17). In other respects the sheep were all sound and healthy, and as far as could be ascertained "in lamb," mating having taken place in the autumn of the previous year in accordance with local practice.

TABLE I.—INITIAL BLOOD ANALYSIS AND BODY WEIGHTS.

January 18th, 1933.

	Sheep No.	Ca.mg.p.c.	P.mg.p.c.	Hb.gm.p.c.	Hb.* Sheep scale	Weight, lbs.
			FED LOT.			
	1	10.50	4.22	9.80	86	100
	2	9.25	5.51	10.70	93	126
	3	9.55	3.42	9.25	81	117
	4	10.25	3.97	10.15	89	113
	5	9.75	5.15	9.50	83	110
	6	8.30	4.02	10.25	90	102
	7	8.70	3.61	7.84	68	118
	8	7.65	3.35	9.70	84	110
	9	10.10	4.03	8.63	75	103
	10	8.20	3.94	10.40	91	116
Average	1–10	9.23	4.12	9.62	84	111
			UNFED LOT.			
	11	7.00	4.98	8.80	77	97
	12	9.30	4.69	11.85	103	120
	13	9.60	4.21	12.85	112	116
	14	8.50	6.27	10.80	94	116
	15	9.60	5.35	10.30	90	104
	16	8.70	4.43	10.75	93	109
	17	8.70	2.93	11.10	97	115
	18	9.50	4.81	12.90	112	101
	19	9.10	6.19	7.72	67	115
	20	8.90	4.42	11.00	96	102
Average	11–20	8.88	4.82	10.80	94	109
Average for	20	9.04	4.48	10.21	89	110

* 11.45 gm. p.c. Hb. = 100.

Blood samples were collected, and weights recorded every month until and through the lambing season. The ewes ate their cake satisfactorily and appeared to benefit from a general health point of view, an opinion borne out by the testimony of the shepherd and farmer. The average figures for the two lots of ten sheep over the whole experimental period are given in Tables II and III, from which it will be seen at once that the figures throughout for Ca. and P. show no significant change, and that the mineral-rich cake made no difference to the blood picture of the fed ewes as compared with that of the unfed ewes.

The interesting figures from Tables II and III are those portraying the history of the hæmoglobin in both the fed and the unfed sheep. It will be seen that in each lot the hæmoglobin undergoes a gradual but steady decline towards and through the lambing period, picking up again in July. The true physiological

explanation of these low hæmoglobin figures is obscure. Unfortunately, it was not possible to investigate fully this apparent anæmia, but it may here be remarked that it is curious that the lowest figures were obtained from the fittest ewes, that is, those receiving the special food. It might reasonably have been expected that the hæmoglobin in the fed lot would have kept up in a manner parallel with the general health and vigour which they manifested. That this did not occur is interesting, and perhaps significant. The figures relating to body weights are shown in Tables IV and V. With the exception of sheep Nos. 10, 11, 12, 14, 15 and 16, little fluctuation in body weights was recorded until lambs were born, when the weights dropped correspondingly.

TABLE II.—AVERAGE BLOOD FIGURES THROUGHOUT EXPERIMENTAL PERIOD.

FED LOT.

	18.1.33	15.2.33	15.3.33	11.4.33	13.5.33	25.7.33
Calcium mg. p.c. ...	9.23	9.00	8.78	8.82	8.81	9.89
Phosphorus, mg. p.c. ...	4.12	4.27	4.79	4.53	4.82	4.96
Hæmoglobin, gm. p.c. ...	9.62	8.73	7.43	7.36	7.28	9.41
Hæmoglobin, Sheep scale	84	76	62	62	61	82

TABLE III.—AVERAGE BLOOD FIGURES THROUGHOUT EXPERIMENTAL PERIOD.

UNFED LOT.

	18.1.33	15.2.33	15.3.33	11.4.33	13.5.33	25.7.33
Calcium mg. p.c. ...	8.88	8.35	8.96	9.24	9.36	10.10
Phosphorus, mg. p.c. ...	4.82	4.84	4.56	4.91	5.36	4.73
Hæmoglobin, gm. p.c. ...	10.80	9.54	9.00	8.67	8.05	10.99
Hæmoglobin, Sheep scale	94	83	79	76	70	96

Clinical observations of the lambing period made it quite clear that feeding the mineral-rich cake had not prevented the occurrence of "cripples." Out of a total of 222 lambs, 144, or 65 per cent., suffered from "cripples." Of these, about 86, or 60 per cent., were from "fed" ewes, and about 58, or 40 per cent., were from "unfed" ewes. It is interesting to note here, however, that, bearing in mind the vigorous and healthy condition of the ewes on the special cake, one of the peculiar facts about "cripples" is that more cases, and the most severe ones, come from the biggest and healthiest looking ewes.

TABLE IV.—BODY WEIGHTS OF FED LOT (LBS.).

Sheep No.	18.1.33	15.2.33	15.3.33	11.4.33	13.5.33
1	100	102	103	81*	103
2	126	125	128	140	127
3	117	117	114½	Missing	88
4	113	111	113	93*	102
5	110	110	112	90*	95
6	102	102	104	116	99
7	118	117	119	96*	84
8	110	111	110	119	106
9	103	103	104	110	101
10	116	104	110	121	107
Average	111	110	111	107	99

Those marked * had dropped a lamb previous to weighing. All had lambed by 13.5.33.

TABLE V.—BODY WEIGHTS OF UNFED LOT (LBS.)

Sheep No.	18.1.33	15.2.33	15.3.33	11.4.33	13.5.33
11	97	93	93	102	113
12	120	115	116	125	153
13	116	115	115	92*	95
14	116	116	116	127	108
15	104	104	107	114	99
16	109	105	101	93*	104
17	115	109	113	92*	99
18	101	99	100	110	96
19	115	115	116	98*	96
20	102	103	102	113	102
Average	109	107	107	106	106

Those marked * had dropped a lamb previous to weighing. All had lambed by 13.5.33.

The affected lambs all showed the usual clinical signs of " cripples " to a greater or less degree, as described in Stewart's[1] article on " Cripples." Cases varied from lambs so badly affected that they were unable to use their limbs, through varying degrees of stiffness to those cases where the symptoms were only obvious to the experienced eyes of the shepherd and owner. The lambs were otherwise fairly alert and willing to suckle when able to reach the dam. Whether much pain is suffered is debatable. Usually, affected lambs do not struggle or flinch when handled, and there are no swellings in the region of joints, whilst the eyes remain bright. On the other hand, in some cases considerable panting was observed, whilst the stiff gait and disinclination to rise tend to indicate a certain amount of pain. It is the opinion of those working with "crippled" lambs on this particular farm that these lambs do suffer to a considerable extent, while chronic cases lose condition and become emaciated.

Blood Analysis of Lambs.—The blood of a number of " crippled " lambs was analysed for calcium, phosphorus and hæmoglobin, and the figures compared with corresponding lambs of the same age from a farm out of the " cripples " area. Tables VI and VII show that there is no significant difference between the two lots of lambs, and that " crippled " lambs would appear to be normal in the blood content of calcium and phosphorus. This, combined with the fact that the blood of the mother, with the possible exception of hæmoglobin, is also normal throughout the period of gestation and lambing, would appear to dispose of any contention that " cripples " in lambs is caused by an insufficiency of minerals in the blood.

Milk Analysis.—It was thought that an analysis of milk from ewes with " crippled " lambs might reveal interesting data, and accordingly samples of milk from ewes with " crippled " lambs, and from ewes with normal lambs, were drawn into bottles and analysed. The results of these analyses showed that there was nothing the matter with the milk from the ewes with " crippled " lambs. It will be seen from Table VIII that a comparison between such milk, milk from ewes with normal lambs, and milk from a totally different source, reveals the absence of any significant difference.

TABLE VI.—BLOOD FIGURES IN "CRIPPLED" LAMBS.

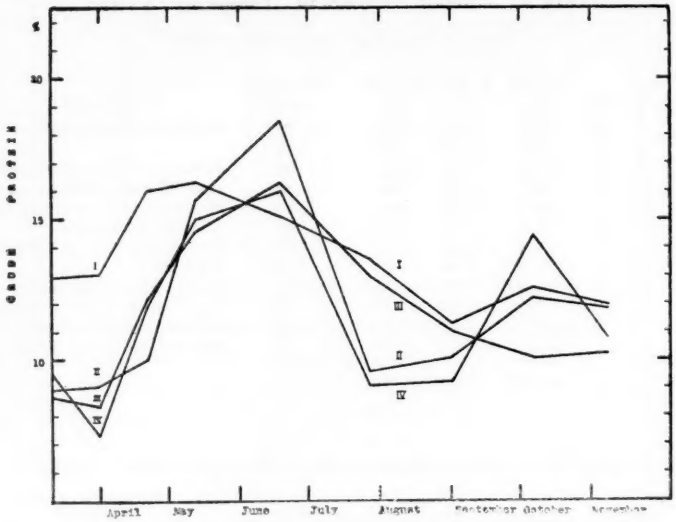
Date of Sampling, April 27th, 1933.

No.	Age days	Sex	Ca. mg. p.c.	P. mg. p.c.	Hb gm. p.c.	Hb (Sheep scale)	Remarks.
1	6	m	11.2	7.11	8.58	75	Affected 3 days ; unable to rise
2	6	m	11.7	7.17	8.60	75	,, ,,
3	6	m	11.5	8.30	11.30	99	Affected 2 days ; scarcely walk
4	4	f	12.6	7.50	8.63	75	Just affected ; able to walk
5	10	f	12.3	6.48	9.90	86	Badly affected ; getting better
6	10	m	11.5	7.52	9.10	79	Affected for 3 days
7	7	f	11.4	6.55	9.70	85	Been "down" ; getting better
8	6	f	11.8	6.70	10.20	89	Affected
9	14	m	11.8	8.20	10.20	89	Still stiff ; getting better
10	10	m	11.0	6.35	10.10	88	Unable to walk yet; getting better
11	10	m	11.3	7.67	5.70	50	Affected 7 days; still unable to rise
12	20	f	11.4	8.18	7.72	67	Affected 14 days; unable to rise
Average	9		11.63	7.31	9.13	80	

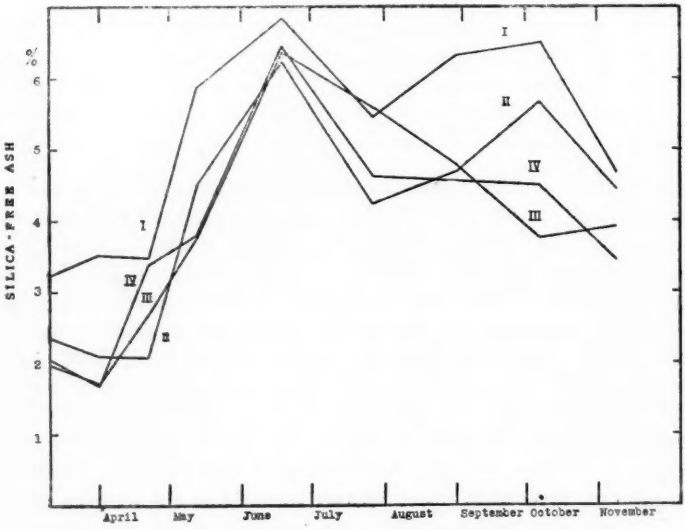
TABLE VII.—BLOOD FIGURES IN "NON-CRIPPLED" LAMBS.

No.	Age days	Sex	Ca. mg. p.c.	P. mg. p.c.	Hb. gm. p.c.	Hb (Sheep scale)	Remarks
1	10	m	11.6	6.92	10.20	89	Single lamb, normal and healthy
2	8	m	11.5	7.14	10.71	94	,,
3	8	m	11.8	8.04	10.70	94	,,
4	10	m	11.3	7.03	8.78	77	,,
5	10	m	11.5	6.96	10.60	93	,,
6	10	f	12.0	6.62	11.40	100	,,
7	8	m	11.5	6.89	10.20	89	,,
8	8	m	11.1	7.94	8.63	75	,,
9	10	m	12.0	7.85	8.39	73	,,
10	7	m	11.3	6.55	9.50	83	,,
Average	9		11.56	7.19	9.91	87	

Grass Analysis.—With a view to obtaining information as to the quality of the natural food of ewes on a "cripples" farm, grass analyses were made, samples being cut about every month, commencing early in March. Tables IX and X give results of these analyses. There is a steady rise in the nutritive value of the pastures examined until June, the protein, oil and minerals all increasing in amount with a corresponding decrease in the amount of nitrogen-free extract and crude fibre. After June there is a gradual decline in nutritive value, the figures approaching those of March once more, although the minerals tend to drop back more gradually. It will be seen that the June figures for calcium and phosphorus are nearly all twice as high as the March figures, and in the case of chlorine, four times as high. This difference was probably largely due to there being very little fresh, green pasture included in the samples when first taken. A comparison with average figures obtained by Orr[3] for different types of pasture (Table XI) shows that during the growing period the two fields compare



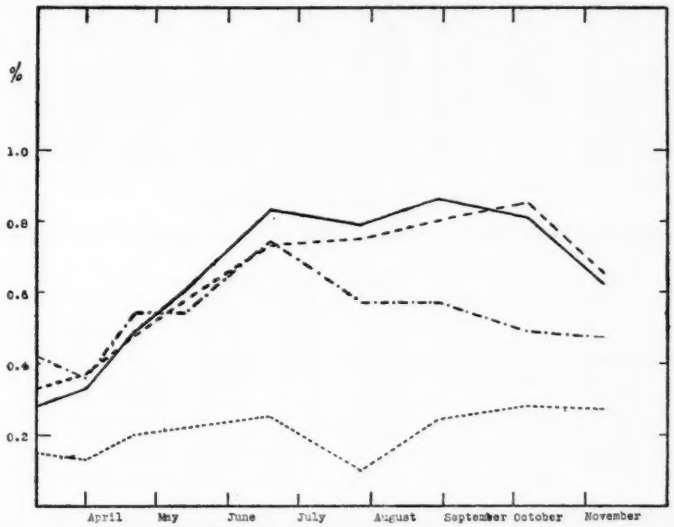
GRAPH I.—Showing the percentage of Crude Protein calculated to 100 per cent. dry matter basis, for the fields Gussethill (i), Lee Head (ii), Backfield (iii), and The Haugh (iv).



GRAPH II.—Showing percentage of Silica-free Ash calculated to 100 per cent. dry matter basis for the four fields as in Graph I.

favourably in mineral content with the figures given for "natural pasture 'all grazed,'" and slightly exceed these in the late spring months.

The accompanying graphs show the variations in (*i*) crude protein, (*ii*) silica-free ash, and (*iii*) chlorine, magnesium, calcium and phosphoric acid. Fields



GRAPH III.—Showing the mean values for the three fields: Lee Head, Backfield and The Haugh—for chlorine, calcium, magnesium and phosphoric acid.
Chlorine ——— ; Calcium oxide – – – – ; Magnesium oxide - - - - - - ; Phosphoric anhydride –·–·–·–·

III and IV are part of the farm on which the experiment under discussion took place, whilst fields I and II are from another "cripples" farm, and have been included for the sake of comparison. It should be noted that sheep were removed from Gussethill (field I) about the middle of May, the pasture being kept for hay. Grazing recommenced towards the end of August.

TABLE VIII.—MILK ANALYSES (PER CENT.).

Ewes with "crippled" lambs	Protein	Fat	Lactose	Ash	CaO	P_2O_5	C.
1	—	5.95	—	0.84	0.25	0.33	0.07
2	4.41	4.75	5.89	0.81	0.22	0.32	0.07
3	5.36	6.55	5.43	0.88	0.27	0.34	0.08
4	5.49	7.12	5.48	1.00	0.29	0.38	0.09
Ewes with Normal lambs							
5	4.99	8.15	5.52	0.87	0.24	0.29	0.07
6	4.76	7.50	—	0.78	0.24	0.26	0.08
7	3.93	5.95	6.09	0.88	0.25	0.32	0.07
8	4.59	6.70	5.46	0.82	0.24	0.29	0.07
Normal ewe from different source	5.60	6.90	5.00	1.00	0.24	0.34	0.13

TABLE IX.—GRASS ANALYSIS.

100 per cent. Dry Matter Basis. Field III, Backfield, Garretshields.

	Crude Protein	Ether Extract	Nitrogen-free Extract	Crude Fibre	Total Ash	Silica-free Ash	Cl.	P_2O_5	CaO	MgO
Mar. 11 ...	8.66	1.95	51.93	29.80	7.66	1.99	0.20	0.34	0.29	0.14
April 1 ...	8.09	1.68	56.06	28.37	5.80	1.70	0.28	0.34	0.32	0.12
April 22 ...	12.44	2.98	51.24	25.69	7.65	4.87	0.49	0.62	0.44	0.21
May 13 ...	14.55	3.38	49.97	23.79	8.31	3.78	0.57	0.61	0.54	—
June 19 ...	16.30	4.67	45.47	25.15	8.41	6.39	0.82	0.79	0.65	0.28
July 28 ...	12.86	4.72	50.31	24.42	7.69	5.59	0.86	0.71	0.77	0.15
Sept. 2 ...	10.88	3.95	51.16	26.07	7.94	4.78	0.84	0.65	0.81	0.28
October 7	10.02	3.56	53.04	25.82	7.56	3.76	0.71	0.40	0.86	0.27
Nov. 9 ...	10.18	3.20	54.30	24.93	7.39	3.91	0.56	0.47	0.70	0.29

TABLE X.—GRASS ANALYSIS.

100 per cent. Dry Matter Basis. Field IV, The Haugh, Garretshields.

	Crude Protein	Ether Extract	Nitrogen-free Extract	Crude Fibre	Total Ash	Silica-free Ash	Cl.	P_2O_5	CaO	MgO
Mar. 11 ...	9.53	2.19	52.38	28.27	7.63	2.04	0.24	0.44	0.30	0.14
April 1 ...	7.33	1.93	53.15	31.74	5.85	1.69	0.28	0.34	0.35	0.15
April 22 ...	11.90	2.76	50.91	25.69	8.74	3.39	0.50	0.52	0.52	0.27
May 13 ...	15.02	3.27	47.76	24.75	9.20	3.80	0.61	0.59	0.53	—
June 19 ...	16.10	4.36	45.40	25.83	8.31	6.45	0.85	0.72	0.68	0.22
July 28 ...	9.07	3.96	53.49	26.08	7.40	4.62	0.73	0.51	0.72	0.08
Sept. 2 ...	9.21	3.49	53.33	26.74	7.23	4.57	0.82	0.64	0.74	0.22
October 7	12.42	3.46	51.55	24.50	8.07	4.50	0.76	—	0.75	0.25
Nov. 9 ...	10.67	2.89	53.34	25.80	7.30	3.44	0.55	0.43	0.56	0.25

TABLE XI.—AVERAGE MINERAL CONTENT OF DIFFERENT TYPES OF PASTURE.

(From " Minerals in Pastures," Orr.[3])

	No. of Samples	Silica-free Ash	CaO Per cent.	P_2O_5 Per cent.
Cultivated pasture...	24	6.64	1.00	0.74
Natural pasture, " all grazed "	22	5.85	0.65	0.67
Poor hill pasture, " partly grazed "	35	5.49	0.56	0.60
Island of Lewis	1	—	0.29	0.24
Falkland Islands	55	4.56	0.29	0.54

Summary.

It cannot be claimed that the experiments described have led to specific information as to the cause of the disease known as " cripples," yet valuable information has been obtained which makes it clear that the factor originally suspected, *i.e.*, mineral deficiency, can now be disregarded. Throughout the experiment the figures obtained for serum calcium and inorganic phosphorus have been normal, such fluctuations as were observed in all probability being within physiological limits. Feeding the special cake, rich in minerals and cod-liver oil, did not raise the blood minerals in the ewes, and did not prevent the occurrence of " cripples," which was more serious on this particular farm than it has ever been before. Clear evidence was obtained of a mild degree of anæmia which manifested itself during the later stages of pregnancy. This anæmia disappeared within

two months after parturition. It is of interest to note that the special food did not prevent this anæmia. The two pastures examined are typical of large areas where this disease occurs, and though poorer in nutritive value than lower lying and improved land, show no abnormal figures. The milk from the ewes was normal, as was the blood of "crippled" lambs.

Conclusions.

The whole experiment, which lasted roughly from January to August, may be conveniently summed up as follows:

(1) Feeding a special cake rich in minerals and cod-liver oil to 100 ewes chosen at random from a "cripples" flock did not prevent the occurrence of this disease.

(2) The blood of the ewes in the "fed" and "unfed" lots showed no significant change.

(3) Milk from ewes with "crippled" lambs was normal, as revealed by chemical analysis.

(4) The blood of "crippled" lambs showed no significant difference from that of healthy lambs.

(5) The respective pastures on which the two lots of sheep were grazed, though not rich, were rich enough in those constituents necessary for normal growth as far as could be ascertained from ordinary analyses.

(6) Throughout the period of the experiment, both sets of ewes were in good health and robust condition to all outward appearances.

Acknowledgments.

It is a pleasure to make acknowledgments to Professor Linton and his colleague, Mr. A. N. Wilson, B.Sc., A.I.C., of the Royal (Dick) Veterinary College, Edinburgh, for grass and milk analyses; to Dr. Andrews and Dr. Green, of the Ministry Laboratory at Weybridge, for kindly encouragement in the investigation; and in particular to Mr. W. Lyle Stewart, M.R.C.V.S., of Armstrong College, Newcastle-upon-Tyne, in whose department the work was executed, and from whose own preliminary studies it arose.

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THE VETERINARY PROFESSION IN SOUTH AFRICA: Veterinary Affairs in the Transvaal During the First Annexation (April 12th, 1877, to August 8th, 1881.)

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Introduction.

THE information available is scanty, and is associated with the Second and Third Sekukuni campaigns, and the first Anglo-Boer War. It will perhaps be best to deal with each phase separately, and to add where necessary the veterinary details. For completeness, certain particulars concerning the first Sekukuni war are given. It must be remembered that at this time the only veterinary measures in existence were General Pretorius' proclamation of 1854, and Law 3 of 1870, both directed against pleuro-pneumonia of cattle.

First Sekukuni War (June, 1876—February, 1877).

Although taking place prior to the first annexation, it is convenient to refer to this war, as the chief sufferers from a veterinary aspect, the Lydenburg Volunteer Corps,[1] remained in the Low Country of the Eastern Transvaal for three months after annexation (disbanded 18.6.1877) by the British Government.

After President Burgers had failed to subjugate Sekukuni at his stronghold —Dsjate—on August 1st, 1876, it was decided to defend the line of the Steelpoort River with a party of volunteers (Lydenburg Volunteer Corps) based on Fort Burgers. Aylward (1878) states that " by December 1st, of sixty horses that had reached us (*i.e.*, at Fort Burgers), twenty-two were already dead of horse sickness ; a few had been stung by the fly in Olifant's Poort-nek, these had also died."

Aylward, who succeeded Capt. von Schlieckmann[2] as commandant of the L.V.C., gives a map at the end of his book showing the approximate westerly limit of tsetse-fly in the Eastern Transvaal during this period. Although not in accord with the data compiled by Fuller (1924), it is interesting that there was a marked indentation westwards along the Olifant's River reaching almost as far as the Spekboom-Steelpoort Confluence.[3] In the circumstances, and assuming that there had been no marked alteration in distribution during the previous forty years, it seems extraordinary that Trigardt's party of Voortrekkers should have selected the Olifant's River Valley for the passage of the Drakensberg to Lourenco Marques in the summer of 1837–38.

Second Sekukuni War (March, 1878—October, 1878).

Whatever may have been the benefits of the British régime, the defence of isolated villages and scattered farms in the Eastern Transvaal certainly left much to be desired. Sekukuni, although apparently repentant, was not long before showing defiance to his new masters. To make matters worse, the administrator of Sekukuniland, Capt. Marshall Clarke, R.A., was absent in Natal during the

FIG. 1.
Major-General Sir Francis Duck, K.C.B., F.R.C.V.S.
(Late Director-General Army Veterinary Department)

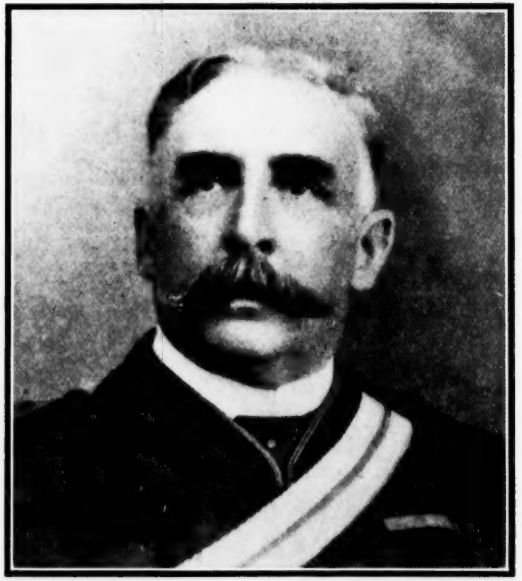

FIG. 2.
Colonel B. L. Glover, C.B., F.R.C.V.S.
(Army Veterinary Department)

(*Article by* H. H. Curson, F.R.C.V.S., *page* 64).

last quarter of 1877, raising recruits for the Zulu Police required for his district. Incidentally, it may be mentioned the European officers received £50 per annum as horse allowance. In March the position steadily became worse, the enemy overrunning the country north of Lydenburg, and only centres such as Lydenburg and the Pilgrims' Rest Goldfields being safe for Europeans. In April, Capt. Clarke managed to defeat the neighbouring Legolani's tribe, but the chieftainess herself, with many warriors, was able to join Sekukuni. The main difficulty was the lack of any defence organisation. When certain provisional police were raised, only twenty-two horses were available for fifty-six men (Aylward, p. 329). Further, although Capt. Clarke had been promised 150 mounted volunteers, he received only 50 men, who were ill-equipped, not even being provided with horse-shoes (*id.*, p. 329).

At length, in June and July, sufficient mounted volunteers arrived, and these were concentrated, along with native forces, at Forts Weeber, Mamalube and Faugh-a-Ballagh, and on the Dwars River.

It is convenient now to mention some facts about these volunteer units. The first to arrive in the Transvaal was Carrington's Mounted Infantry,[4] which during the summer of 1877–78, at Pretoria, was "nearly dismounted" by horse sickness. The Diamond Fields Horse,[5] about 100 strong, "were nearly driven to mutiny by neglect and the noticeable want of provision for their equipment" (*id.*, p. 338). Worst of all, the mortality among the horses was high, and volunteers "were forced in a pestilential climate to pay for their own horses." The troops referred to above numbered approximately 250 Europeans and 600 natives, with "at least six pieces of artillery," but two unfortunate incidents weakened the morale of the Europeans, and brought the Zulu police to mutiny. On July 26th, six horses and seventeen head of cattle "were carried off from . . . Fort Faugh-a-Ballagh . . . and on August 7th, a party belonging to the D.F.H. was surprised on the Dwars River, and lost fifty-two horses and forty-eight oxen." ("Narrative of the Field Operations Connected with the Zulu War of 1879," page 7. London: Harrison & Sons.) As the D.F.H., owing to this loss, "was now rendered almost useless" (*id.*, p. 8), and the native police had mutinied (9.8.78), General Thesiger, G.O.C. S. Africa (headquarters Pietermaritzburg) since 4.3.78, decided to send the 80th Regiment to the Transvaal for garrison duty, thus setting free the 1/13th Regiment for active service. Soon after this, during September, the Frontier Light Horse, about 200 strong, arrived from Kaffraria, having marched *via* Kokstad, Pietermaritzburg and Newcastle. Colonel Rowlands, V.C., was now placed in command of all troops in the Transvaal. After some reorganisation, chiefly in the abandonment of the line of communications from Pretoria along the Elands and Olifants Rivers, and the decision to make Lydenburg the base of operations, Colonel Rowlands concentrated his force at Fort Burgers by the end of September (*id.*, p. 9).

On October 3rd, Colonel Rowlands marched out with a force including the F.L.H. and some M.I., and two 7-pounder Krupp guns, his objective being a

position near Sekukuni's stronghold, about twenty-five miles distant, and from which he could harass the marauders. On the night of October 4th, while repelling an attack of the enemy on the camp, " the firing caused a stampede of some of the horses and of the slaughter oxen, and the latter were not recovered " (*id.*, p. 9). Shortage of water and lack of pasturage, along with heavy work, led to complete exhaustion of the horses and oxen, with the result that it was decided to return to Fort Burgers, which was reached on October 7th. During this march the column lost fifteen horses killed or died of horse-sickness, and four horses and one mule wounded. Realising " that the exceptional dryness of the season rendered an advance impossible," further operations against Sekukuni came to an end soon afterwards, and the Imperial troops returned to garrison duty. The F.L.H. proceeded to the Transvaal-Zululand border, as trouble with Cetywayo was then threatening. In regard to this campaign, Surgeon-General Ross, in his article " Remarks on Epidemic Diseases—Men and Animals—in the Colony of Natal," which appeared in the *Transactions of the Epidemiological Society*,[6] estimates that 90 per cent. of the horses died.

Two veterinary officers took part in the above campaign, First-Class V.S. Duck, who accompanied the F.L.H., and V.S. Glover, who performed general duty.[7] The former, now Sir Francis Duck, in a private communication, mentions that in the Sekukuni campaign " we lost heavily from horse-sickness." Gudgin[8] also states that " horses required shoeing once a month " on account of the wear resulting from the stony ground.

The year 1878 was a notable horse-sickness year, military movements in low-lying country both in Natal and Transvaal being the chief contributing cause. Indeed, the date 1878 should be regarded as a landmark in South African veterinary history, for in this year no less than three reports on horse-sickness were issued. The first was drawn up by a board of three officers[9] which met at Pretoria by order of General Thesiger " to report upon a fatal disease among the horses there." As neither the Board nor the witnesses possessed any veterinary knowledge, not even " Mr. Wood, farrier and acting veterinary surgeon, whose treatment of the disease was specific " being examined, the report was of little value. It was stated, however, that " the percentage of deaths among the Army horses was high ; in one lot of sixty-nine, as many as twenty-three had succumbed between February 9th and April 8th." Needless to say, " the Board could not arrive at any conclusion as to the origin of the malady, nor how to prevent it, considering that of twenty-one deaths, thirteen of the horses had been stabled."

In June, there was published in Natal, by direction of the Lieutenant-General (*see* Government Notice No. 192, *Natal Government Gazette* of June 25th, 1878), a report on horse-sickness by Wiltshire, S., the veterinary surgeon of the Colony. He identified the disease as " anthrax fever resulting from the action of a poisonous agent ingested with the food."[10] Finally there appeared a pamphlet, by Veterinary Surgeon Glover, entitled " Suggestions for the General Management of Horses and Mules while on Field Service in Natal and the neighbouring Countries, with

Notes Concerning their More Common Ailments."[10] Norris-Newman, C.L. (1880), states (p. 13) that a list of prescriptions was appended. The same authority also informs us that this pamphlet was one of three publications issued to the troops prior to the Zulu War of 1879, the other two being " The Zulu Army," and " Regulations for Field Forces in South Africa." The last named, among other particulars, contained rules as to " horses, sick horse and remount depôts . . . cattle and other prizes. . . ." Glover mentions not only horse-sickness, but glanders in horses and mules, and lung sickness and red-water in oxen. He believed, influenced no doubt by Wiltshire, that horse-sickness was akin to anthrax, in fact he called it anthrax fever. Glanders, he stated, was " at all times more or less prevalent in Natal," and lung sickness was also to be " met with all over the Colony." Red-water, he added, was " prevalent between November and April . . . " in most parts of Natal, the greatest mortality occurring along the principal highways."

Third Sekukuni War (October—December, 1879).

The Zulu War over as a result of the victory at Ulundi (July 4th, 1879), and Cetywayo a prisoner, Sir Garnet Wolseley, now G.O.C. South Africa, proceeded to Pretoria *via* Utrecht and Wakkerstroom during September. In the meantime Colonel Baker-Russell, who had operated during the recent campaign with his Flying Column on the N.W. border of Zululand, organised the Transvaal Field Force at Middelburg for operations against the defiant Sekukuni. It had been decided to make Fort Weeber,[11] eighteen miles S.W. of Sekukuni's stronghold, the base for supplies, and at this point the troops assembled at the end of October, but no forward move was possible until November 20th. By November 27th, Sekukuni's stronghold, *i.e.*, including the village, his kraal, and the hitherto impregnable fighting kopje on Dsjate farm, was surrounded by approximately 2,200 Europeans, Imperial and Colonial troops, and 8,000 natives, chiefly Swazies, who had advanced not *via* Fort Weeber, but from Lydenburg. It is not possible to state the number of mounted men engaged, but the official telegram of November 25th, 1879,[12] makes reference to " 300 horse."

Colonel Baker-Russell's plan of attack was to capture first a flat-topped mountain which overlooked the Fighting Kopje, and on whose western face were situated Sekukuni's kraal and village. This position captured, the second and final attack was to secure the honey-combed Fighting Kopje to which the Bapedi warriors would retreat. " The first phase was carried out by three separate columns converging from the north (Carrington's), the south (Ferreira's), and the east (Bushman's),"[13] early on the morning of November 28th, and by noon the Fighting Kopje was in the possession of the British. Sekukuni, however, escaped, but was caught by a patrol under Colonel Ferreira on December 2nd.

With Carrington were the Border Horse, the Transvaal Mounted Rifles, and some British Mounted Infantry, and with Ferreira, commander of his own unit, Ferreira's Horse, dismounted, of course, for the final operations. Also participating in the campaign were the Lydenburg Mounted Rifles, a squadron of

the 1st (King's) Dragoon Guards (Fig. 3), and the Transvaal Artillery. In the first attack local troops were employed, but in the final assault the Imperial contingent (21st Fusiliers, 94th Regiment, and a detachment of 80th Regiment) fought shoulder to shoulder with their Colonial comrades. Mule wagons were used for conveyance of some of the infantry.

From a veterinary aspect the campaign was characterised by the use of as few horses as possible. Surgeon-General Ross,[14] writing on November 8th, 1879, states : " the poor horses are now dying off rapidly of this inscrutable malady, *i.e.*, horse-sickness," and it is clear from a report entitled " Observations on Cases of Horse-sickness," by Messrs. Jackson and Moore, that the disease was severe.

Veterinary-Surgeon R. Moore, attached to the 1st (King's) Dragoon Guards, was in charge of the Veterinary Department[15] of the Field Force, and Sergeant-Major R. W. Jackson belonged to the Army Medical Service. Their publication (*see* title page, Fig. 4) was the first professional publication printed in the Transvaal, and it was republished under Government Notice, No. 243, in the *Natal Government Gazette*, of June 15th, 1880.[16] They refer to the pamphlet drawn up by Glover in 1878, and " the Annual Report of the Colonial Veterinary Surgeon," *i.e.*, Wiltshire, of Natal, as being the only literature available, indicating they had not seen Wiltshire's contribution issued as Government Notice No. 192 of 1878, where he had, among other statements, attributed horse-sickness infection as " resulting from the action of a poisonous agent ingested from the food."[17] The authors, although " suggesting " that the diseases affecting horses during the campaign were (1) hyperæmia of lungs, (2) bronchitis, and (3) a fever of continued type, nevertheless believed horse-sickness to be a " malignant fever of enteric type," apparently since " congestion of the bowels " was a prominent post-mortem feature. It is gratifying they were not impressed with the views that food, water or air were responsible for the disease.

In a former communication (Curson, 1931) it was stated that T. P. Gudgin, inspecting Veterinary Surgeon during the Zulu War, also served in this campaign. Although not accompanying the Field Force, it is presumed he was either at Pretoria or Pietermaritzburg. In his " Report of the Zulu War," dated Aldershot, April 14th, 1880, he refers to Cape horses being shod all round in the Sekukuni campaign, and not in the Zulu War, fore shoes being sufficient. The context indicates that the Third Sekukuni operations are meant (p. 20). The date of the Report, April 14th, 1880, would seem further to indicate that Gudgin did not return to England immediately after the Zulu War, as the other army veterinarians apparently did. Smith (1927) makes no mention of the Sekukuni campaigns.

First Anglo-Boer War (December, 1880—March, 1881).[18]

This war, one of the most disastrous in the history of British arms, commenced on December 16th, 1880, when the opening shots were fired at Potchefstroom. The struggle, widely known for the Boer victories in Natal, is also memorable for the gallant defence made by the besieged British garrisons at

seven widely separated centres in the Transvaal. This campaign taught, as no other campaign, the value of mounted troops in South African warfare, for the Boers almost to a man possessed horses. As in the Zulu War, there was not a single Imperial cavalry regiment in South Africa at the outbreak of hostilities, the last regiment, the 1st (King's) Dragoon Guards having left for India the previous August. The only mounted troops in the Transvaal were about 100 M.I. drawn from the two infantry battalions constituting the garrison. Further, permission had been granted to Commandant I. Ferreira, C.M.G., to recruit men from Pretoria for a mounted corps (Ferreira's Horse) destined for the Basuto War, in which the Cape Government was engaged. In this way about 300 men who would have been useful to the British authorities were drawn into another sphere. Finally, Colonel Bellairs, O.C. Transvaal, had also proposed that the horses of the 1st K.D.G. should be made available for M.I., but the suggestion was turned down and the animals sold. It being found necessary to buy other horses, Capt. Lambart " had been sent, in October, from Pretoria to purchase horses in the Orange Free State to complete the artillery and mounted infantry " (p. 70). He was on his return journey with between forty and fifty horses when he was captured within a day's journey of Pretoria.

In Natal there was still a small detachment of 1st K.D.G. awaiting transport to Great Britain, and on the commencement of hostilities, this, with a troop of M.I. drawn from the Natal garrison, was sent to the border. After communication with the Transvaal had been interrupted, Sir George Colley, now G.O.C. Natal and Transvaal, and Governor of Natal, instead of awaiting cavalry reinforcements at Newcastle, his base, pushed on towards the Transvaal-Natal border, hoping to relieve Standerton by January 20th, 1881. At this time railhead was at Pietermaritzburg, the line having been opened from Durban on December 1st, 1880. Meanwhile the Dutch had invaded Natal and seized the strategic position of Laing's Nek. It was in the effort to force this passage to the north that General Colley suffered the reverses at Laing's Nek (28.1.81), Ingogo (8.2.81), and Majuba (26.2.81).

Smith (1927) gives the names (p. 258) of eleven veterinary officers who were present in this campaign, which he calls the Transvaal War, 1881. Most, if not all, arrived after the armistice had been arranged (6.3.81). The names are: T. P. Gudgin, F. Duck, J. D. Lambert,[19] J. Reilly (not C. G.), G. Durrant, A. A. Jones, B. L. Glover, C. W. Gillard, D. C. Pallin, C. Rutherford and T. Caldecott. Not only are some of these names incorrect, but it would seem that the names of J. Findlay, W. Pallin, J. Hanly, and W. D. Sartin should be added. In the Transvaal there was no Imperial veterinary officer, the last having been Mr. R. Moore, whose regiment, the 1st K.D.G., had left South Africa in August, 1880. In fact, until the arrival of Arnold Theiler, in 1891, and the visit of Capt. Horace Hayes, in 1892, no veterinarians can be traced as having been in the Transvaal since Moore's departure.

There is little to add regarding veterinary matters at the various beleaguered

centres except at Pretoria. Here, on account of the large population, Colonel Bellairs made elaborate preparations for a siege. Two mounted volunteer corps, Pretoria Carbineers, 100 strong, and Nourse's Horse, 60 strong, were enrolled, and horses were impressed for their use. Assistant Commissary-General Walton not only " efficiently organised " the Remount and Transport services, but was also in charge of the Sick Horse Depot. His O.C. writes of him (p. 238) as " a very deserving officer of superior abilities." In a previous despatch Colonel Bellairs refers (p. 209) to valuation boards as " consisting of civil officials and gentlemen well acquainted with marketable prices," being appointed " to regulate and fix the value of all horses, cattle . . . seized for the necessities of the garrison and townspeople." In this connection a District Order, dated 3.1.1881, signed by Colonel Bellairs (p. 461) states : " Horses which have been commandeered from private individuals for the public service will, if desired, be returned to the owners at the close of hostilities.

" Such horses, to avoid permanent disfigurement, will be only branded on the hoof, but will be valued the same as others, and compensation granted in case of loss while in public employment.

" Owners desirous that this arrangement should be carried out, should at once notify their wishes in writing, describing their horses to the garrison Adjutant."

Of over 3,000 animals belonging to the garrison, 1,600 were slaughter oxen. The difficulty in providing grazing for such a number was great, but as the besieging force was kept at a distance of some miles from the fortified camp,[20] it was possible not only to pasture over a wide area, but also to make hay, mowing machines being worked in the surrounding country under special guard. Approximately fifteen oxen were slaughtered daily for the besieged, who numbered nearly 5,000 souls.

Horse-sickness did not make its appearance until the commencement of February, but the losses then were so severe that Colonel Belliars (p. 474) wrote : " The daily decreasing number of horses arising from horse-sickness and war casualties, gradually but surely lessens our power for offensive operations." In one week in March, 30 horses died. Altogether during the siege 215 horses and 65 mules were expended, 45 and 21 respectively being lost in action. In the *News of the Camp* of 10.2.81, a paper published during the siege, the following passage occurs : " If there are to be any further reconnaissances or attacks upon the enemy's position . . . it is well they were done quickly ; but a general spread of this disease leaves our troopers horseless, exclaiming with Richard—' A horse ! A horse ! My kingdom for a horse ' " (p. 205). Guns of N/5 Battery R.A. were at Pretoria and Potchefstroom during the sieges. Forage rations were issued each day as follows : English horses, 10 lb. oat hay, 8 lb. mealies, ½ oz. salt. Officers' chargers, 10 lb. oat hay, 8 lb. mealies, ½ oz. salt. Colonial horses, 2 lb. oat hay, 8 lb. mealies, ½ oz. salt. Mules 10 lb. mealies or kafir corn " (p. 472).

Duval, C. (1884), the editor of the newspaper mentioned above, in his book (p. 249) refers to a case of glanders during the siege. He also tells an amusing story of an officer who, having been appointed to give evidence on two boards of inquiry, namely, on a sick soldier and on the glandered horse, when asked to give his opinion, horrified the court by advising "shoot him at once." It appears he was being questioned regarding the sick soldier, whereas he believed the glandered horse was under consideration. An astonishing incident during the siege was a strike of the civilian medical men, who objected to performing certain medical duties on the grounds of insufficient remuneration. They were being paid £1 1*s*. p.d., plus free rations for families and servants, and private practice was also allowed. They demanded £5 5*s*. p.d., or that their resignations should be accepted. When it is considered that civil surgeons in the Zulu War, for instance, were paid £1 1s. p.d., and that other civilians gave their services gratis, it is not surprising that the O.C. preferred to do without their services.

At Potchefstroom, the garrison of about 200 men with some refugees were besieged in a fort thirty yards square. Two wells were sunk for water in the enclosure, but owing to impossibility of watering the horses and mules, 197 animals in all, these, except a favourite charger, were turned loose and fell into the hands of the Dutch. The officer's charger, although twice wounded, lived throughout the siege. The commissariat oxen, numbering 147, were lost a day after the siege commenced.

At Rustenburg the slaughter cattle were lost early in the siege, while at Marabastad the horses belonging to the Transvaal Mounted Police, about fifty, chiefly bastards, and most of the cattle, were captured after the siege had been in progress for two months. Fresh meat, however, was available throughout the siege, "the last beast having been killed the day the news of the peace was received" (p. 296). There were sieges also at Lydenburg, Wakkerstroom and Standerton, but nothing of veterinary interest is to be recorded.

Conclusion.

Just as the first annexation of the Cape Colony (1796–1803) led to the appointment of Thomas Burrows the first veterinarian (Curson, 1931), so the First Annexation of the Transvaal resulted in the arrival of its pioneer veterinarians, namely, Messrs. Duck and Glover, in 1878. (*See* Figs. 1 and 2).

APPENDIX.

Pioneers of the Profession in the Transvaal: Francis Duck, B. L. Glover, R. Moore, T. P. Gudgin.

Sir Francis Duck (1845–19—).—As an excellent biographical notice appears in Smith (1927), pp. 197–199, there is no need for repetition here. Sir Francis, who lives in Southern Rhodesia, has been an honorary associate member of the South African Veterinary Medical Association since July, 1928. He was S.V.O., Army Veterinary Department, S. Africa, from 1882–1885.

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BENJAMIN LUCAS GLOVER (1848–1904), the son of Surgeon-Major Glover, M.D., of the H.E.I. Company, was born on December 21st, 1848, and qualified at London on 26.4.1876. He obtained the F.R.C.V.S. on 26.4.93. He joined the R.A. on 27.8.70, and in 1877, with Veterinary Surgeon Duck, was selected for duty in South Africa with the Field Force commanded by General the Hon. F.A. Fliesiger (later Lord Chelmsford). He saw service in the Ninth Kafir War (1877), and was present in the operations against Sekukuni, and did good work in the Zulu War, being mentioned in despatches, and receiving promotion to V.S., First Class, on 4.9.80 ; Veterinary Major on 4.9.80 ; Lieut.-Colonel on 28.6.97 ; and Colonel on 5.10.02. Glover also saw much service in India, being present in the operations on N.W. Frontier (1897–8), with the Tirah Expeditionary Force as Inspecting Veterinary Officer, for which he was mentioned in despatches and received the C.B. Previously he had done good work in N.W. India in connection with horse breeding operations, and had served with the Army Remount Dept., during which he visited North America. From 1903 until his death he acted as P.V.O., 3rd Army Corps in Ireland, with rank of Colonel. He died on 18.4.1904, and was buried in Dublin. His photo is taken from THE VETERINARY JOURNAL, IX, New Series, 1904.

R. MOORE, (18 –1913), qualified at New Edinburgh Veterinary College in 1875, and gained the Fellowship in 1884. He served with the 1st (King's) Dragoon Guards, which formed part of Transvaal Field Force in the campaign against Sekukuni in 1879. Colonel Baker-Russell, in his Sekukuni despatch, referred as follows to Moore : " V.S. Moore . . . attended to wounded horses on the field with great coolness " (THE VETERINARY JOURNAL, X, p. 210). In 1888 he visited South Africa with the 9th Lancers, but returned shortly afterwards. He was appointed Professor at Aldershot Army Veterinary School in 1897, succeeding Major S. Longhurst. Colonel Moore died in 1913.

TOM PARINDER GUDGIN (18 –1889)[21] qualified at London in May, 1850, and became a Fellow in 1877. He apparently joined the Army soon after, for according to the Army List of January, 1856, he was then a regimental V.S. He served through the Crimea (with Scots Greys at Balaclava), and Indian Mutiny, and was gazetted as P.V.S.[22] during the Zulu War (1879), on which he furnished a most exhaustive report. Although his services were praised, yet his only reward was a good-service pension of £50 per annum (THE VETERINARY JOURNAL, 1896, p. 394). He was placed on retired pay on 27.7.1885, and died in 1889.

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[1] The first irregular volunteer unit raised in the Transvaal.
[2] Killed by natives, 17.11.1876.
[3] Where Fort Burgers was situated.
[4] Called also Carrington's Horse by Aylward (p. 224), but not to be confused with Carrington's Horse of the Bechuanaland Campaign of 1884–5.
[5] Not the regular volunteer unit, 215 strong, which saw service in the Langeberg Rebellion of 1897.
[6] Quoted by *The Veterinarian*, Vol. LXI, p. 150.
[7] These veterinarians were therefore the first members of our profession in the Transvaal.

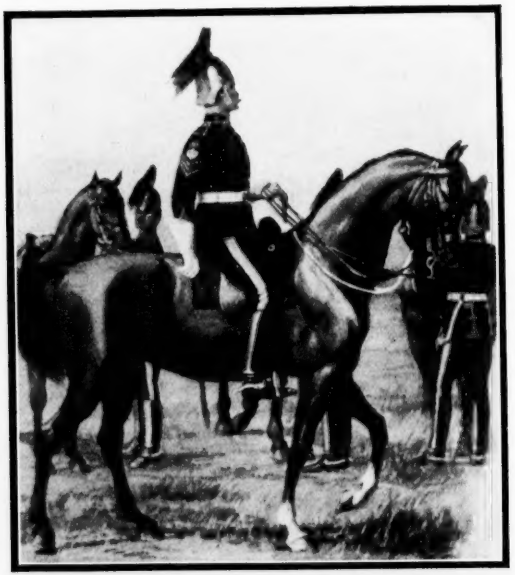

FIG. 3.
Regimental Dress of the Farrier Sergeant-Major.

OBSERVATIONS

OF CASES OF

HORSE-SICKNESS,

BY

R W. JACKSON, S.M.,

AND

R MOORE, M.R.C.V.S., A.V.D.,

KING'S DRAGOON GUARDS

PRICE, TWO SHILLINGS.

PRETORIA:

PRINTED BY COPPEN, DEECKER AND Co.,

1880

FIG. 4.
Title-page of First Professional Publication in the Transvaal.

(*Article by* H. H. Curson, F.R.C.V.S., *page* 64)

[9] General Report, Veterinary Dept. Zulu War, 1879, p. 20. London: Harrison & Sons, 1881.

[9] "The Horse-sickness of South Africa." Abstract in THE VETERINARY JOURNAL, VII, p. 100, 1878.

[10] "Horse-sickness and Other Diseases of Animals in South Africa." Abstract in THE VETERINARY JOURNAL, VIII, p. 97, 1879, of both Wiltshire's and Glover's publications.

[11] First established by President Burgers in 1870, after first Sekukuni war.

[12] See p. 266, "In Zululand with the British in 1879," by Norris-Newman, C.L.

[13] Extracts from "Memoir of Major-General Sir Hugh McCalmont," *The Ranger*, December, 1927, p. 129.

[14] *Loc. cit.* footnote 6.

[15] The veterinary officers of the cavalry were not departmentalised until 1881.

[16] The paper cover was maroon, the colour of the Veterinary Service since 1874.

[17] It is, of course, possible that Wiltshire had expressed this view prior to June, 1878, but his annual reports from 1874–1879 are not available.

[18] Based on "The Transvaal War, 1880–81," edited by Lady Bellairs. London: Wm. Blackwood & Sons, 1885. Carter's "Narrative of the Boer War" (J. C. Juta, 1896), has also been consulted. This campaign was the first where British troops were exposed to a breech-loading fire (despatch of 18.3.81, from Administrator to Earl of Kimberley), and the last in South Africa where the Imperial troops wore red coats and white helmets.

[19] Lambert was P.V.S., A.V.D., with headquarters at Pietermaritzburg for a period of ten months (probably April, 1881–January, 1882). In October, 1881, he published a paper on "Horse-sickness or Anthrax in South Africa." See Government Notice No. 488 in *Natal Government Gazette* of November 1st, 1881.

[20] The nearest laager was at Wonderboom Poort, about six miles north of Pretoria.

[21] As stated in the context, it is not clear whether Gudgin actually entered the Transvaal.

[22] Thus enjoying all the privileges of the higher rank, a precedent hereby being created.

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WHAT ABOUT VETERINARY EDUCATION?*

By C. H. STANGE,

Iowa State College, U.S.A.

A STUDY of the developments in veterinary medicine since 1900 is a very revealing and instructive occupation if one is interested in the future of his profession. Moreover, it is difficult to avoid the conclusion that there should be some guiding influence if the future of veterinary medicine is to avoid some of the errors of the past. It is the author's intent to refer to some significant facts out of the past which should receive consideration in developing future plans, rather than try at this time to outline detailed requirements.

* Read at the 17th Annual Meeting of the American Veterinary Medical Association, Chicago, August, 1933.

In order to make the best possible use of these facts we should decide, as far as possible, one of the most fundamental questions, and one that should not be left to chance, *viz.*, what is to be the future field of veterinary medicine, and the coming status of the veterinarian? During the past quarter of a century we have observed a great change in the character of the service rendered by the veterinary profession. Many of our problems to-day are of State, National, and even International character, whereas formerly we were concerned quite largely with individuals. Future changes will depend on several factors, among which are: the character of training given to veterinary students, the number of veterinarians graduated into the profession, scientific discoveries and economic conditions.

In some countries veterinary medicine is much more inclusive than it is in the United States. Should we in this country expand our conception of veterinary medicine, and include much of what is not now included primarily in our field, as, for example, animal breeding and nutrition, diseases of fish, game and honey-bees? To what extent should the veterinary profession enter into public health work? These and other questions are pertinent in this connection because, if veterinarians are to be interested in these additional lines of service, their interest must be aroused, and the fundamentals at least must be given them while they are students.

The influence of training on the future interest of the veterinarian is well illustrated by the difficulties in getting some members of our profession, who were educated primarily in diseases of the horse, to interest themselves in diseases of cattle and swine. Those who received some education in cattle and swine diseases, generally speaking, could not be interested in poultry diseases unless they had some training along this line as students. The lack of interest in food hygiene in many sections is undoubtedly due very largely to the fact that the veterinarians as students received little or no instruction in this subject.

Danger of an Insufficient Number of Veterinarians.

It may be somewhat difficult, on first thought, to appreciate how the number of veterinarians graduated into the profession could influence the future scope of the service rendered, but it is easier to understand that if the veterinary profession suffers numerically our field will be invaded by charlatans and non-professional men of various kinds, as well as by members of allied professions which may be crowded. If our profession is well filled, not only will such invasion be difficult, but veterinarians will fill the positions properly coming in the field of veterinary service. It may be observed in a number of lines of work, many of them of an institutional or Governmental nature, where non-professional men or members of other professions are holding positions which could be more efficiently served by men with a veterinary training. No doubt this is partially due to the fact that such fields have not seemed sufficiently attractive to graduates in veterinary medicine, but in many cases the principal reason has been that the colleges did not offer work which adequately prepared young men for such

service. As long as our profession is not crowded there will be no urge for young men with veterinary training to permeate into all the fields which veterinary medicine could best serve. On the contrary, veterinarians will pick the fruit which looks best, and is most easily obtained, and leave the rest to others who may help themselves.

As to the scientific discoveries and their influence on the field of veterinary medicine, I need to refer to only one example to impress this upon your minds. When one contemplates the effect of the discovery of the cause of hog cholera and the resultant immunising process, we can appreciate the significance of a single discovery as far as veterinary service is concerned.

The import of economic conditions is so fresh in our minds that it requires no more than brief mention. During economic depressions, members of any profession naturally gravitate into those lines of work which are least affected. During recent years small-animal practice apparently has not suffered to the same extent as have some other branches, and as a consequence an undue proportion of veterinarians have become small-animal practitioners. In other lines of practice the owner attempted to help himself to a much greater degree, and in many cases did not have the money to pay a veterinarian even if he employed one. It is obvious that we cannot consider a period covering but a few years in outlining plans for the future. During periods of depression there are too many of everybody, and too much of everything. During our most prosperous times the reverse is true. During depressions, veterinarians complain about the profession being crowded, and during prosperous times they complain about the invasion of the field of veterinary medicine by others. We may expect both of these complaints, depending on the economic conditions prevailing. It seems to the writer that a survey of the future demands and opportunities for veterinarians and the extent of the field of veterinary service would be a very fruitful work for this association to undertake.

Responsibility of the Veterinary Colleges.

The future of the veterinary profession, both qualitatively and quantitatively, is in the hands of the veterinary colleges. It is but reasonable therefore that this Association, which represents the entire profession of this country, should be vitally and actively interested in what the veterinary colleges are doing now, and propose to do in the future. Because of the significance of and interest in both the number and qualification of the men being graduated, these questions are given special consideration in this paper.

No doubt we can all agree that we should have enough men in the profession to render all the service which properly comes under the scope of veterinary medicine. The difficulty lies in deciding how many men this would require, as it is so largely dependent upon undetermined factors already enumerated. Only a very wise man or a fool would venture to predict what conditions will prevail five years hence, which is the time now required after graduation from

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high school until completion of the course in most of our leading veterinary colleges. The best we can do, therefore, is to study our own developments during the past twenty years, and use this as a basis to guide us in the future.

In making these studies I have used official figures supplied by the U.S. Bureau of the Census, and there has been no differentiation of graduates and non-graduates. This may be objected to by some, but what the writer has been attempting to get at was the question of veterinary service in its entirety. If a non-graduate retires, although we may ridicule the service he has been rendering, it nevertheless provides an opening for another veterinarian.

In the census of 1900 we had in the United States 8,149 veterinarians and fourteen veterinary colleges. In ten years we had a gain of 3,503 (43 per cent.) in the number of veterinarians, making a total of 11,652. The number of veterinary colleges increased nearly 29 per cent., or to eighteen. During this period the number of graduates from the schools in the United States increased from 131 to 592 per year, with an average of 347.7 per year. If the graduates from the Canadian Colleges are included, we would have an increase from 191 graduates in 1900, to 613 in ten years, or a total production over this period of 4,521.

During the next decade we reached our maximum in number as to colleges, students, graduates and number of veterinarians in the United States. During this time we gained an additional 15 per cent., giving us a total of 13,466. The number of veterinary colleges increased to twenty-three, but by the end of this period seven had closed. During the ten-year period, 1910–1920, the twenty-three colleges produced 7,037 veterinarians, or an average of 703 graduates per year. If we include Canada again, we have a total of 7,895, with an average of 789.5 per year.

Summarising this twenty-year period, beginning with 1900, we find that we graduated in the United States 10,529 veterinarians from twenty-seven veterinary colleges, and including Canada, 12,416 veterinarians from thirty colleges. Of the 10,529 veterinarians graduated in the United States, only 2,629, or approximately 25 per cent., were graduated from colleges now in existence. From 1910 to 1918 inclusive we averaged 757 graduates per year.

Shrinkage in Number of Colleges and Graduates.

Now let us examine what happened subsequent to 1920. The number of veterinary colleges in the United States has been reduced from twenty-three in 1916 to ten at present. Last year we had 1,214 regular classified students in our veterinary colleges, as compared with 2,992 during the college year 1915–16. During the last census period we graduated an average of approximately 191 veterinarians, as compared with the 703 of the previous decade. At the time of taking the last census we registered a loss since 1920 almost as great as the gain we made during the preceding ten-year period. There was a loss of 1,614 (12 per cent). By applying life-insurance and other reliable statistics we can

project the numerical condition of our profession into the future if we accept our present enrolment as fairly stationary.

At the present time we have approximately 10,760 persons under 70 years of age reported as veterinarians. By graduating 240 men per year, which is four more than we graduated this year, our profession numerically would eventually reach a level 40 per cent. below the 1920 figure. This study has revealed that we have approximately 2,000 fewer veterinarians under 65 years of age now than we had in 1920. There are almost the same number of veterinarians over 65 years of age as there are under 40 years (18–19 per cent). If we separate the most active forty years of the average man's life (twenty to sixty) into two equal periods of twenty years each, we find that 65 per cent., or nearly two-thirds, of the veterinarians between twenty and sixty years are in the upper group, while only 35 per cent. fall in the lower twenty-year period. This is not surprising when we remember that it has been fifteen years since a large class in veterinary medicine was graduated, and that the first classes graduating during the heavy production period have been out of college for twenty-five years or more. If we make a distribution in order to enable us to compare the 1920 and 1930 census figures, we find that of the veterinarians from 25 to 65 years of age in 1920, 43 per cent. were from 45 to 65 years of age, while in 1930 the proportion had changed to 55 per cent.

Over-production leads to a demoralising and altogether undesirable condition in any profession. It leads to decreased opportunities in the profession, and thereby makes it less attractive to the ambitious and more desirable type of young men. It leads to a lowering of ethical standards and the employment of professional men in the trades and common labour classes. We have only to observe the conditions in some of the other professions to note the serious results from such a condition. At the present time there are very few, if any, graduates from recognised veterinary colleges who are driving taxicabs, attending filling stations, or doing any one of a number of other kinds of work not considered even in a remote way as professional. The writer doubts if any of the other professions have a better record in this respect than ours.

A careful study of the alumni of two of our older and well-established veterinary colleges revealed the fact that approximately 96 per cent. of the graduates in veterinary medicine followed their profession. This reveals, on the whole, general satisfaction with their chosen profession. It also gives us a basis for estimating the number of graduates necessary to maintain the profession. With this in mind, and considering the natural death-rate, we need to graduate between 340 and 350 men per year to maintain an active profession of 12,000. This is below our 1920 census figure, which gave us 12,342 under sixty-five years of age. Unless the number of graduates from the veterinary colleges increases approximately 47 per cent. above this year's class, we will not have a profession which will be capable of rendering the necessary veterinary service this country needs. Any increase or decrease in the scope of our service would, of course, affect this figure.

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Public Lack of Comprehension of Veterinary Matters.

When we come to consider the character or quality of the men whom we should graduate, we face a more difficult and intangible problem. We gain nothing as a profession by being particular who enters our front door, and then leaving the back door wide open. Since all of our present veterinary colleges are a part of a university or state college, it should be one of our principal objectives to create a better comprehension of the field and objectives of veterinary medicine. In this connection, perhaps the irritating and resentful word "ignorance" should not be used, because it creates a resistance to reason which counteracts any efforts at correction. The fact cannot be denied, however, that in the field of education, and to a large extent outside, from the average man to the university and State executives, there is a lack of comprehension of veterinary matters that ranges from public misconception to unjust administrative decisions along with dangerous legislative enactments, much of which is due to pedagogic sophistry. Inadequate education in veterinary medicine is no better if provided in the name of the State, than under any other label. Hydrargyri chloridum corrosivum is just as poisonous as corrosive sublimate.

If this Association has the courage to establish reasonable minimum requirements, it can do much for the future veterinary profession. The difficulty will probably lie in agreeing on what are reasonable requirements. Practically every veterinary college has two sets of requirements, *viz.*, those for entrance and those for graduation. The entrance requirements now vary from graduation from high school, to one year of successful college or university work. Many of the courses which have been introduced into the high schools of the country are of the manual arts variety, and do not provide the mental discipline necessary to enable a young man to pursue a curriculum dealing with the medical sciences. Permit me to illustrate. The subject of immunology is so complex, and, if carefully studied, contains more material of essential value in disease control than did the entire course in veterinary medicine, with the possible exception of anatomy, when many of my listeners were students.

Better Prepared Students Necessary.

I will not prolong this discussion by citing other examples, but it must be obvious that the students must come to us better prepared, and spend more time after they arrive, if they are to master the medical sciences. If the plan of some of the universities and colleges, to confer the B.S. degree based on four years of high school and two years of college or university work, is generally adopted, it is not impossible that the B.S. degree should be required for entrance to veterinary colleges. As yet we are not aware of the motives back of this movement, and we must be careful not to get caught in the jig-saw puzzles of some of our modern educators. The requirements for graduation are probably more important than those for entrance, yet on the whole they have received much less consideration. They should include a desirable character and personality as well as an accumulation of technical ideas and ability to pass written examinations.

As long as we have colleges primarily interested in quantity, with little or no emphasis on quality, there can be little progress. This Association could be of material assistance in shifting the emphasis to the proper place.

Even when provided with good entrance material it is difficult enough, with the limited financial support which even the best colleges have to-day, to accomplish our aims in an educational way. The writer believes that the most essential thing to be accomplished in a veterinary college is the teaching of the fundamental medical sciences. If these are not mastered in college, they certainly will not be studied after graduation. Colleges are often criticised for not producing a finished product, or in other words, not being practical. To put it in another way, we are accused of neglecting the art of the practice of veterinary medicine; but we must remember that the science of veterinary medicine, if it comes at all, must come before the art. The more we train our students in the art of the practice of veterinary medicine and neglect the science, the closer we approach the empirics of old, many of whom certainly understood the art of practising veterinary medicine.

The writer suggests, and this is not an original idea, that as a future requirement for graduation an internship with some successful practitioner be considered. For this we must have practitioners who have been keeping abreast of the scientific developments in veterinary medicine as well as cultivating the art. A practitioner who scoffs at every idea in his professional work which is new to him would not prove a desirable tutor. We can afford to ignore those " practical " zealots who look upon the application of the modern scientific developments in the practice of our profession as ignoble and unworthy. They remind one of the outdoors man who boasts about his ability to " rough it," whereas the use of a few conveniences civilisation has provided would have changed the outing from a miserable nightmare to a very pleasant experience. It is utter nonsense to refuse to apply the aids and conveniences science has provided to our everyday problems. Much of the progress which has been made during the past few years in the treatment of parasites, especially in small animals, has been made possible largely through the more general use of the greatest aid to the naked eye—the microscope. This one illustration will suffice to illustrate the point under discussion.

Let us so administer our requirements that the well-known poem, when paraphrased as follows, will not apply to our profession :

Some were graduated for great things,
And some were graduated for small;
And of some, it is not recorded
Why they were graduated at all.

A CASE OF RINGWORM IN THE CAT COMMUNICATED TO MAN.

By BASIL WALPOLE, M.R.C.V.S.
London.

THE subject in question was a blue Persian kitten, aged three to four months, which I was called in to examine, the owner having recently purchased it from a shop. I was informed by my client that she was suffering from an affection of the skin, which was attributed to an infection from the kitten. The lesions were present on her chest. Cat mange was suggested. The kitten was taken away and examined, and no trace of mange was found upon microscopical examination. The kitten was kept under observation for a fortnight, when I was informed that my client's little girl, the servant, and the charwoman, were now subjects of a similar affection of the skin. As ringworm had now been definitely diagnosed by the medical skin specialist, the kitten was examined in consultation with Professor Wooldridge; and, after careful exploration, two small lesions a little larger than a pin's head were discovered in the region of the shoulder and tail. Material was taken, and a microscopic examination definitely established that the kitten was the subject of ringworm.

In view of the contagious nature of the disease, the uncertainty of cure and the protracted treatment in a long-haired animal, the owner decided to have it destroyed. The kitten had been fondled by each member affected, the animal thus coming in contact with the naked skin, and the ringworm lesions made their appearance on those who had been actually handling the animal; the lesions being principally confined to the parts of the skin which had been in intimate contact. The parasite was identified by Professor Wooldridge as the microsporon *felinus*.

OBSERVATIONS ON THE VIRUS OF CONTAGIOUS PUSTULAR DERMATITIS.

By F. H. MANLEY, B.V.Sc., M.R.C.V.S.
Veterinary Officer, Cyprus.

Introduction.

LITERATURE relative to this disease shows that it evidently exists in many parts of the world, and is known under various names, such as contagious pustular stomatitis, infectious labial dermatitis, and ecthyma contagiosa.

The disease in Cyprus is found in sheep and goats, and is of some economic importance. In several outbreaks a considerable mortality, possibly due to interference with feeding, has been recorded. Under natural conditions the disease is apparently of more frequent occurrence in goats than in sheep, and it is definitely seasonal, occurring usually during the first three months of the year.[1] The climatic conditions during these three months are usually cold and wet. The clinical characters of the disease and the lesions which follow experimental

vaccination have been described by several investigators, and it is not proposed to review here the relative literature. Amongst the earliest investigators, the cause of the disease was attributed to staphylococci or *B. necrophorus*. More recent workers, however, have proved that the disease is caused by a filtrable virus. Aynaud[2] was evidently the first to show that the causal agent was of the nature of a virus. It has also been shown that experimental vaccination of sheep and goats with the virus produces lesions closely resembling those of the vaccinia-variola group. In 1925, Gordon[3] made a detailed study of the viruses of vaccinia and variola, and the scope of his work prompted several of the experiments carried out in this investigation on the virus of contagious pustular dermatitis.

Viability of the Virus.

Desiccation.—Glover[4] stored dried crusts at a low temperature, and found them still potent when retested after two years seven months. Theiler[5] obtained positive results with powdered crusts which had been preserved for fourteen months. The experiments carried out here indicate that the potency of the virus in dried crusts stored at room temperature is well maintained for at least eight months.

Experiment 1.—Dried crusts which had been collected from two outbreaks of the disease in sheep were kept at room temperature for eight months. One per cent. emulsions of each specimen of crusts were then made in 50 per cent. glycerine saline, and two sheep were inoculated from each emulsion by applying the material to the lightly scarified skin on the inner aspect of the thigh. Three sheep reacted, and one sheep failed to react.

Experiment 2.—The crusts used in this experiment were obtained from infected goats. After being dried and kept at room temperature for eight months, a 1 in 200 emulsion of the dried crusts was made in 50 per cent glycerine saline. When two sheep were vaccinated with this material one exhibited a mild reaction, and the other failed to react.

Experiment 3.—Crusts obtained from another outbreak of the disease in goats were dried and kept at room temperature for about eight months. 0.15 gm. of the crusts were emulsified in 15 c.c. of distilled water. The material was allowed to stand in a 30 c.c. measuring-glass for two hours. The supernatant fluid was then centrifuged for three minutes at 2,000 r.p.m., and again decanted. One sheep vaccinated with a 1 in 1,000 dilution of the above in saline gave a typical though mild reaction. A sheep vaccinated with a 1 in 10,000 dilution failed to react.

Action of Glycerine.—Theiler (*loc. cit.*) reports that he was able to conserve the potency of scabs in 50 per cent. glycerine for weeks and months. Glover[6] has shown that loss of infectivity is marked in 50 per cent. glycerine after preservation for various periods.

Experiment 4.—A 1 per cent. solution of sheep crusts in 50 per cent. glycerine saline was kept in the ice chest for seven months. Four goats and two sheep were then vaccinated, with negative results.

Experiment 5.—Dried sheep crusts were emulsified in saline to make a 1 per cent. solution. This was centrifuged for three minutes at 4,000 r.p.m. The supernatant fluid was mixed with an equal volume of glycerine. Two sheep were vaccinated with this material and gave typical reactions, vesico-pustules appearing on the fourth day. Twenty-three days after this material had been prepared it was tested on two sheep and one goat. One sheep and the goat reacted mildly. The other sheep failed to react. Thirty-six days after preparation the material was tested on two sheep. Both failed to react. This experiment clearly indicates that there is a fairly rapid loss of potency when the virus is kept in 50 per cent glycerine.

Viability Under Natural Conditions.

Experiment 6.—Saline emulsions were made from crusts of Cyprus and English ovine strains which had been exposed on the ground in February and March for thirty-one days. The scarifications were carried out on the shaved back of the sheep, and both reactions were doubtful positives. After sixteen days' storage in the ice chest the material was re-tested, the scarifications being carried out on the shaved abdominal wall of a sheep ; no reactions occurred.

Experiment 7.—Crusts exposed on the ground for twenty-three days in April and May were desiccated, mixed with a small quantity of saline, and tested on a sheep with negative results. Similar crusts exposed for ten days during May were tested on another sheep with negative results.

Experiment 8.—Dried crusts of Cyprus sheep, strain LL, were placed on the ground in the shade of a thick bush for twelve days. They were then again desiccated for twenty-four hours over H_2SO_4, emulsified in saline, and placed in the ice chest for about twenty hours. Lamb No. 135, which was inoculated on the scarified abdominal wall with this emulsion, gave a typical reaction. Exposure to direct sunlight would appear to be the necessary factor for the destruction of the virus under natural conditions. Some confirmation is obtained for this fact in that the disease is definitely seasonable in Cyprus, and is of very rare occurrence during the summer months.

Action of Heat.—The effect of heat on the virus was ascertained by placing the various emulsions in small tubes in the water bath.

Experiment 9.—Saline emulsions of the English, Cyprus and Australian ovine strains were made in dilutions of 1 in 100, and about 2 c.c. of each emulsion was distributed in small tubes and heated in the water bath at 55° for forty-five minutes. All strains were then tested on the same sheep in dilutions of 1 in 100, 1 in 1,000, and 1 in 10,000. No reactions occurred.

Experiment 10.—A 1 in 100 saline emulsion of Cyprus goat strain was prepared ; 2 c.c. were placed in a small specimen tube (No. 1), and heated in a water bath at 55° for twenty-five minutes. Two c.c. of unheated emulsion were placed in another small tube (No. 2), and both tubes placed in the ice chest for about twenty hours. From each tube dilutions of 1 in 100, 1 in 1,000, 1 in 10,000 and

1 in 50,000 were prepared, and tested on the scarified abdominal wall of goat No. 26. All dilutions from tube No. 1 were negative, while all dilutions from tube No. 2 gave positive reactions.

Experiment 11.—A 1 in 1,000 dilution of virus was heated at 54° for fifteen minutes. When subsequently tested on sheep No. 34 in various dilutions no reactions occurred. At the same time No. 34 reacted to unheated virus similarly diluted.

Experiment 12.—A 1 in 1,000 dilution of the same virus was heated at 55° for ten minutes. When the material was tested on sheep No. 30 reactions occurred in dilutions up to 1 in 75,000. The reactions from the 1 in 50,000 and 1 in 75,000 dilutions were mild.

Disinfection Experiments.

Several tests were carried out to determine the power of certain disinfectants to destroy the virus *in vitro*. The disinfectants were first prepared in strengths equal to twice the final dilution required, and similarly saline emulsions of the virus were prepared of known dilution.

Experiment 13.—(*a*) A 1 in 100 saline emulsion of strain LL was distributed in ½ c.c. amounts in small tubes. The disinfectants were added to each tube in similar quantities, so that the final dilution of virus was 1 in 200. Contact was allowed for twenty hours at room temperature, the inoculations being subsequently carried out on the shaved back of a sheep.

Potassium permanganate in the above dilutions and 50 per cent. glycerine failed to kill the virus in twenty hours.

Disinfectant.	Final Dilution.	Result
Carbolic acid	1 in 20	—
Carbolic acid	1 in 100	— ?
Formalin...	1 in 200	—
Formalin...	1 in 2,000	—
Potassium Permanganate	1 in 10,000	+
Potassium Permanganate	1 in 20,000	+
Mercuric chloride ...	1 in 10,000	—
Mercuric chloride ...	1 in 20,000	—
Glycerine, 50 per cent ...	—	+
Water, 50 per cent. ...	—	+

(*b*) This test was repeated on another sheep with freshly prepared reagents, with the same results, except that carbolic was definitely negative. The scarifications were now carried out on the abdominal wall.

Experiment 14.—On another sheep this test was repeated, but the time of exposure of virus to disinfectant was only two hours.

Disinfectant.	Dilution.	Result
Carbolic acid	1 in 20	—
Carbolic acid	1 in 200	—
Formalin...	1 in 200	—
Formalin...	1 in 2,000	—
Potassium permanganate	1 in 10,000	+
Potassium permanganate	1 in 20,000	+
Mercuric chloride ...	1 in 10,000	—
Mercuric chloride ...	1 in 20,000	—

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The results obtained with the various disinfectants used indicate the comparatively low power of potassium permanganate to destroy the virus. This is interesting in view of the directly opposite results with similar dilutions obtained by Gordon (*loc. cit.*) with vaccinia. He concludes his section on disinfectants with the following paragraph: "The outstanding feature of these disinfection experiments is the very high value that potassium permanganate appears to possess for destroying *in vitro* the virus of vaccinia."

Effect of Gravity.

Experiment 15.—Six c.c. of a 1 in 100 saline emulsion of a goat strain were placed in a small tube and allowed to stand in the ice box for about twenty hours. One c.c. was then taken from the top of this tube, and dilutions up to 1 in 50,000 prepared. All dilutions gave positive reactions when subsequently tested on a goat.

Experiment 16.—A 1 in 1,000 emulsion of strain F was placed in a vertical tube 17.5 cm. long, and 0.25 cm. in diameter. It was allowed to stand for twenty-four hours. About 1 c.c. of the top layer was taken and tested on sheep No. 28 in various dilutions up to 1 in 75,000. All areas showed positive reactions.

Effect of Centrifugation and Filtration.

Experiment 17.—*Centrifugation.*—About 5 c.c. of a 1 in 1,000 dilution of strain F was centrifuged for one hour at 3,000 r.p.m., and the top layer used for the test.

Filtration.—A 1 in 1,000 dilution of F was incubated for twenty-four hours at 37° One hundred c.c. of a 1 in 2,000 dilution of F, so treated, was passed through a Berkefeld filter at 8–10 inches mercury pressure. The above emulsions and a control were tested on sheep No. 28 in dilutions of a 1 in 2,000, 1 in 10,000, 1 in 50,000, and 1 in 75,000. The filtrate was positive only up to 1 in 10,000, the other emulsion being positive in all dilutions.

Experiment 18.—*Centrifugation.*—A 1 in 1,000 dilution of F was centrifuged at between 2,500 and 3,000 r.p.m. for forty-five minutes, and the upper layer from the centrifuge tube used for the test.

Filtration.—Filtrate was prepared by incubating a 1 in 2,000 dilution of strain F for twenty-four hours at 37°, then passing the material through a Berkefeld filter under 10 inches of mercury pressure. Sheep No. 35 was inoculated by scarification with various dilutions of the above two preparations and a control emulsion. The control and the centrifuged material reacted in dilutions up to 1 in 100,000. The filtrate reacted in dilutions up to 1 in 10,000 only. Experiments 17 and 18 appear to confirm an unusual fact, reported previously by Aynaud (*loc. cit.*), namely, that it is impossible to throw down the virus even by considerable centrifugation.

Relative Potency of Various Strains.

Experiment 19.—Various specimens of desiccated crusts were emulsified in saline. The scarifications were carried out on the shaved back of a ram:

RESULTS.

Virus.	Dilution and Result. 1–100	1–1,000	1–10,000	1–100,000
Cyprus Caprine	+	+	—	—
Australian Caprine	+	+	—	—
Cyprus Ovine	+	+	+	+
English Ovine (*a*)	+	+	+	+
English Ovine (*b*)	+	+	+	+
Australian Ovine	+	+	+	+

Both goat strains gave mild positive reactions. The most severe reactions were produced by the Australian ovine strain.

Active Immunity.

Successful immunisation against natural infection in the field is carried out in France by the use of a glycerinised emulsion of the dried crusts. Several workers have reported that immunity can be produced by vaccination. Glover (*loc. cit.*) says: "Sheep which have passed through a natural attack of the disease possess a solid immunity against re-infection. Moreover, recovery from the experimental disease, which is much less severe, confers a high degree of resistance. By the ninth day of the disease there is some resistance to re-infection, and this immunity becomes progressively more solid, until, by the fifteenth day, when the lesions have advanced to the scab stage, it is absolute."

Seddon and Belschner[7] report that sheep which have suffered a natural or an experimental infection and have recovered, are thereafter immune to the homogeneous or any other Australian strain. Our experiments indicate that a considerable degree of immunity is produced subsequently to artificial infection, but a solid immunity has not been obtained.

Experiment 20.—Sheep No. 19 was vaccinated by scarification with a 1 in 1,000 saline emulsion of Cyprus sheep strain (LL). A moderate reaction occurred. Twenty days later she was tested with various dilutions of English, Cyprus and Australian ovine strains, the scarifications being carried out on the shaved skin of the abdominal wall. The resulting reactions were as follows:

Virus	Dilution and Result. 1–100	1–1,000	1–10,000
English Ovine	+	—	—
Cyprus Ovine (LL)	++	+	+ (very mild)
Australian Ovine	+	+ (1 pustule)	—

These three strains are invariably active in a dilution of at least 1 in 30,000 when tested on susceptible sheep, and a considerable degree of immunity was apparently produced in sheep 19. The immunity was, however, not solid.

Experiment 21.—A second test appeared to confirm the above result. Lamb No. 131, when previously vaccinated with the Cyprus ovine (LL) strain, reacted to dilutions up to 1 in 30,000, but did not react to a dilution of 1 in 100,000. After twenty-eight days she was again vaccinated with the following results:

Virus.	Dilution and Result. 1–100	1–1,000	1–10,000	1–100,000
Cyprus Ovine (LL)	+	(?)	—	—

The scarifications were carried out on the skin of the abdomen as before.

Experiment 22.—Sheep No. 20 was inoculated by scarification with 1 in 10,000, and 1 in 50,000 dilutions of Cyprus strain F. All areas reacted typically. Thirty days after this scarification she was inoculated in the same way with 1 in 50 and 1 in 100 dilutions of F and similar dilutions of English strain 332 G. All areas inoculated reacted typically. Sheep No. 17 was inoculated first with various dilutions of strain 332 G, and exhibited typical reactions. Thirty days after she was inoculated with 1 in 50 and 1 in 100 dilutions of strain 332G and F. All areas showed typical reactions. No resistance to a virus dilution of 1 in 100 was therefore demonstrable in vaccinated sheep Nos. 20 and 17.

Experiment 23.—A 1 in 100 saline emulsion of F was centrifuged for one hour at 2,500 r.p.m. Sheep Nos. 4 and 25 each received 0.2 c.c. of the clear fluid subcutaneously under the tail. The inoculation was made with a dental syringe. A typical reaction only about two centimetres in diameter occurred at the site of inoculation. Both sheep were subsequently tested with various dilutions of strain F, and both reacted in dilutions up to 1 in 75,000 (limit of test). In these cases a mild vaccination reaction produced no immunity to a subsequent inoculation of virus in a 1 in 75,000 dilution.

Serum Verucidal Antibody.

Aynaud (*loc. cit.*) was apparently unable to demonstrate any virucidal or immunising power in serum from recovered animals. In one case he placed 1 c.c. of serum from a recovered animal in contact for four hours with 0.1 c.c. of a 1 in 400 dilution of fresh virus. A control serum was used, and he found that the lesions were perhaps a little more marked on the control side. Various dilutions of the inoculum were apparently not tested. Aynaud also inoculated a lamb with 240 c.c. citrated blood taken from two immune animals, and found that on subsequent inoculation it presented the usual lesions. He concludes as follows: "En résumé, il est impossible de mettre en évidence des réactions specifiques dans le serum des animaux infectés ou immunisés. On sait que dans le vaccine on a mis en évidence un pouvoir virulicide très net des humeurs ; c'est un difference de plus entre les deux affections. Dans la stomatite, l'immunité est tissulaire et non humorale."

Virucidal Power of Immune Serum *in vitro*.

Experiment 24.—Serum for this test was obtained from sheep No. 24 immediately after it had recovered from an artificial infection due to inoculation by scarification with Cyprus sheep strain (LL). The virus used was 1 in 500 saline extract of "LL" strain. In an agglutination tube 0.5 c.c. of the extract was mixed with 0.5 c.c. of serum 24. In another similar tube 0.5 c.c. of the extract was mixed with 0.5 c.c. of serum from a presumed clean sheep. Both tubes were incubated at 37° for four hours, and then tested on sheep No. 18. The final dilution of the extract was 1 in 1,000 in each tube. Sheep 19 was also tested with a 1 in 1,000 dilution of the same extract without the addition of serum. Inoculation was carried out by scarification of the shaved abdominal wall.

RESULTS.

Sheep No. 18.	Sheep No. 18.	Sheep No. 19.
Serum 24 side	Control side	Virus only
Fifth day : few small vesico-pustules	Few small vesico-pustules	Three large vesicles
Seventh day : few minute pustules	One large pustule and several small pustules	Several pustules
Ninth day : healed	Several pustules	Several pustules

Under the above conditions the serum from the recovered sheep appeared to inhibit the activity of the virus.

Experiment 25.—Equal quantities of a 1 in 500 dilution of strain F and serum 20 (from recently reacted sheep No. 20) were mixed in one tube, and virus plus control serum in another. The sera had previously been heated at 54° for fifteen minutes. Both tubes were now incubated at 37° for three and three-quarter hours, and the mixtures tested in various dilutions on sheep No. 34. The virus, plus serum 20, reacted in dilutions up to 1 in 1,000, while the virus plus control serum reacted up to 1 in 50,000.

Experiment 26.—This test was repeated with a similar virus and serum 20, serum 32 (control), and serum G (from pox-recovered goat). The sera were first heated at 55° for twenty minutes. Three tubes were then put up, each containing equal parts of virus and the various sera. They were incubated for five hours at 37° C., and then placed in the ice box for eighteen hours prior to inoculation by scarification. Material from tubes containing serum 32 and serum G reacted up to 1 in 50,000 (limit of test), from the tube containing serum 20 this dilution was negative, and the 1 in 30,000 dilution reacted mildly, only one pustule being produced.

Virucidal Power of Hyper-Immune Serum *in vitro*.

Experiment 27.—An attempt was made to hyperimmunise sheep No. 24 by intravenous inoculation of 5 c.c. of Cyprus sheep virus, strain LL, in a dilution of 1 in 100. Four inoculations were given at five-day intervals, and serum then obtained for test. A tube containing this serum and another containing control serum were heated in a water bath at 55° for twenty minutes ; 0.5 c.c. of the heated serum 24 was then added to a similar amount of a 1 in 500 dilution of virus LL in a small tube. The final dilution of virus in each case being 1 in 1000. Both tubes were placed in the incubator at 37° for four hours prior to being tested on lamb No. 131. Lamb No. 132 was used as a control, being inoculated with dilutions of the same virus without the addition of serum. In this test falling dilutions of the virus and the serum-virus mixture were inoculated on the scarified abdominal wall.

Final dilution of virus	Lamb No. 131 : Serum 24 side.	Lamb No. 131 : Control serum side	Lamb. No. 132 : Virus alone
1 in 1,000	+	+	+
1 in 10,000	?	+	+
1 in 30,000	—	—	+
1 in 100,000	—	—	—
1 in 300,000	—	—	—

+ = moderate reaction.

Experiment 28.—Goat No. 24 recently recovered from dermatitis was inoculated intravenous with 0.1 gm. of goat virus. After eight days serum was obtained. Three small tubes were set up, one containing virus plus serum 24, another virus plus control serum, and another virus only. They were incubated for four hours at 37°. The final dilution of virus was 1 in 2,000. When goat 59 was vaccinated by scarification with material from these tubes, the area inoculated with virus plus serum 24 did not react, while the other two areas showed mild reactions. The results show that the addition of hyper-immune serum to the virus considerably reduced its potency.

Passive Immunity.

Experiment 29.—Lamb 130 (weight 28 lb.) received 8 c.c. of serum from sheep 24 (hyper-immunised) subcutaneously, and four hours later the virus was inoculated by scarification.

RESULT.

Dilution of virus	Lamb 130	Lamb 132 (control)
1 in 1,000	+	+
1 in 10,000	+	+
1 in 30,000	—	+
1 in 100,000	—	—
1 in 300,000	—	—

Experiment 30.—Eight c.c. of serum from reacted sheep No. 20 was inoculated subcutaneously into sheep No. 29, and the following day the latter was tested with various dilutions of virus up to 1 in 75,000. All dilutions produced reactions.

Experiment 31.—Sheep No. 20 was inoculated intravenously with a saline emulsion containing 1 gm. of strain F. A week later a second dose was given. A few days after the second inoculation serum was collected. Sheep No. 16 received 40 c.c. subcutaneously, and the following day was inoculated by scarification with 1 in 1,000, 1 in 10,000, 1 in 20,000 dilutions of F. All areas reacted, and it appears evident that any marked degree of passive immunity to artificial infection is difficult to produce.

Flocculation Reaction.

A laboratory test that would quickly differentiate crusts of contagious pustular dermatitis from those of pox would be of considerable practical value. Graigie and Tulloch[8] have carried out investigations on the flocculation reaction for variola-vaccinia. In par. 1 of their general conclusions they state: "Investigation of further material from cases of variola major, variola minor, vaccinia from man and other animals, and from other conditions, corroborated unequivocally that the variola-vaccinia flocculation reaction is specific, and is of considerable diagnostic value." Using a slightly different technique, Havens and Mayfield[9] were unable to obtain such a valuable conclusion. They consider that the reaction as a diagnostic procedure was valueless owing to the difficulty of interpreting the results. It was considered that this test might prove to be of value in the determination of contagious pustular dermatitis.

Experiment 32 (*preliminary*).—*Antigen.*—0.5 cm. of desiccated crusts (English ovine) were ground in 10 c.c. saline. This was centrifuged for ten minutes at 3,500 r.p.m. One c.c. of the supernatant fluid was added to 1 c.c. serum from sheep 24 (previously reacted to English strain). A dilution of 1 in 40 antigen was also tried. Both results were negative.

Experiment 33.—Saline emulsions were made from an English strain in dilutions of 1 in 100 and 1 in 1,000, and centrifuged for three minutes at 2,000 r.p.m. Sera from sheep No. 24 and from a pox-recovered goat were tested in dilutions of 1 in 4, 1 in 8, 1 in 15, and 1 in 32, against both dilutions of the antigen. Some precipitate was visible at the bottom of all tubes after twenty-four hours at 37°.

Experiment 34.—The technique adopted by Graigie and Tulloch (*loc. cit.*) was now more closely followed. A Cyprus ovine strain (LL) was used, the preparation of crust extract being as follows: 0.05 gm. desiccated crusts, plus 15 c.c. ether. Shake at intervals for one-half hour; centrifuge; remove supernatant ether; dry the residue at 37° C.; make an emulsion with 5 c.c. normal saline; leave at room temperature for two hours; centrifuge.

The extract was then faintly opalescent, and contained no visible particles. The sera used were from sheep No. 24, a recent reactor, and from a control sheep. The tubes were incubated at 37° for twenty hours. The final concentrations of this virus were 1 in 500, 1 in 1,000, and 1 in 2,000. Each concentration was tested against dilutions of these sera of 1 in 5, 1 in 10, 1 in 20, and 1 in 40. There was no appreciable difference between the results obtained with serum No. 24, and the control serum.

Experiment 35.—After sheep 24 had received four intravenous inoculations of virus at weekly intervals, serum was again obtained, and the above test repeated. The serum dilutions were 1 in 20 and 1 in 40, while the virus dilutions were 1 in 400, 1 in 1,000, 1 in 2,000, and 1 in 20,000. The results were again unsatisfactory.

Complement Fixation Reaction.

Since the flocculation test was unsatisfactory, the complement fixation test was tried. Dealing with small-pox virus, numerous observers have apparently obtained positive results, while, on the other hand, many workers have obtained unsatisfactory results.[10]

Reagents.

Experiment 36.—*Serum* 20 = Serum from sheep No. 20 which had recently reacted to inoculation by scarification with various dilutions of strain F (Cyprus). Used in dilution of 1 in 5, except in tube 1, which was undiluted.

Antigen = Various dilutions in saline of desiccated crusts of strain F, centrifuged for a few minutes at 2,500 r.p.m.

Complement = Guinea-pig serum in dilution of 1 in 10 (five hours old). Previously titrated and found active in 1 in 50.

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Serum G = Serum from goat No. 2 recently recovered from a severe natural pox infection. Same dilutions as serum 20.

Serum 32 = Serum from sheep No. 32 from Government Stud Farm, free from pox or dermatitis ; same dilutions as serum 20.

Hæmolytic System = (*a*) Hæmolytic serum (Burroughs Wellcome & Co.). Found active in dilution of 1 in 1,600 on titration ; used in dilution of 1 in 250. (*b*) Washed sheeps R.B.C., 5 per cent. in saline.

Method.

The tubes were put up as follows :

Tube 1	Serum 20	0.5 c.c.	+	0.5 c.c.	Antigen	1 in 100	Complement 0.5 c.c.
„ 2	„	„	„	„		1 in 100	„ „
„ 3	„	„	„	„		1 in 500	„ „
„ 4	„	„	„	„		1 in 1,000	„ „
„ 5	„	„	„	„		1 in 1,500	„ „
„ 6	„	„	„	„		1 in 5,000	„ „

Six tubes were also put up with serum G, and six with serum 32, the same dilutions of antigen being used as with serum 20. After incubation for one hour at 37°, one c.c. of the hæmolytic system was added to each tube. They were then again incubated at 37° for one hour. The six tubes containing serum 20 all gave positive reactions, while all other tubes were negative. However, in spite of the satisfactory results obtained at this first trial, subsequent tests of various sera and antigen have so far been unsatisfactory.

Relationship to Goat Pox.

The question of the relationship of dermatitis in goats to goat pox has been mentioned by Glover,[11] who indicated that the point required further investigation.

Experiment 37.—The goat used in this experiment had just recovered from a severe natural pox infection. Inside the hind leg was scarified and inoculated with an emulsion of pox crusts. The right side of the chest was scarified and inoculated with an emulsion of dermatitis crusts. The former site showed no reaction, while the latter exhibited a mild dermatitis reaction.

Experiment 38.—Another pox-recovered goat was vaccinated with various dilutions of dermatitis virus. Typical reactions were obtained in dilutions up to 1 in 10,000 (limit of test).

Experiment 39.—Goat No. 1 in the final stages of recovery from severe generalised pox was tested by cutaneous inoculation of Cambridge (goat passage) strain and Cyprus strain F, in dilutions of 1 in 100 and 1 in 1,000. All areas showed typical dermatitis reactions. It will also be noticed that in experiment 26 serum from a pox-immune goat failed *in vitro* to reduce the potency of dermatitis virus.

Summary and Conclusions.

Some of the characters of the virus of contagious pustular dermatitis have been examined. In desiccated crusts at room temperature the virus maintained its potency for many months. There is a fairly rapid loss in potency when the virus

is stored in 50 per cent. glycerine saline. Three common disinfectants rapidly killed the virus, which, however, appeared to offer considerable resistance to the action of potassium permanganate, whereas Gordon has shown that potassium permanganate, similarly diluted, appears to possess a very high value for destroying the virus of vaccinia. When the virus of contagious pustular dermatitis is exposed in small tubes in the water bath, the critical temperature appears to be 54° C. for fifteen minutes. The virus has been exposed on the ground, both in direct sunlight and in the shade, direct sunlight apparently being an important factor in the destruction of the virus under natural conditions. The potency of the virus appears to be reduced by filtration through a Berkefeld V gravitation, and a moderate amount of centrifuging does not appear to effect the concentration of the virus.

Cyprus sheep react equally to Cyprus, English and Australian ovine strains. One Australian caprine strain appeared to be of low virulence for Cyprus sheep. Although in some cases vaccination has produced a degree of immunity to subsequent artificial inoculation, in no case has this immunity been absolute.

Contrary to Aynaud's results, our experiments appear to indicate that serum from an animal which has reacted to the virus contains some virucidal bodies. This fact has been demonstrated in several instances, particularly by the action of serum on the virus *in vitro*. The flocculation test and the complement fixation test have not been satisfactory as aids to the diagnosis of dried scab specimens. In demonstrating the relationship of goat pox to contagious pustular dermatitis, pox-immune goats have been proved susceptible to the virus of contagious pustular dermatitis, and serum from a goat recently recovered from severe natural pox failed to reduce the potency of dermatitis virus when tested *in vitro*.

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XUM

B.C.G. VACCINE.

In a discussion on prophylaxis of tuberculosis in the French Senate on July 4th, 1933, the following remarks are reported in *Révue Vétérinaire* for August, 1933. M. Raymond Martin, referring to tuberculin, said: It is an excellent method of clinical investigation. Unfortunately it is not a therapeutic method. In the presence of very numerous cases of bovine tuberculosis, which are always doubtful, like all statistics, we learn that 30 to 40 per cent. of bovines are affected with tuberculosis. How can we fight against this scourge of our herds? To slaughter all tuberculous cattle, as I believe has been done in the United States, might reduce the figure of tuberculosis to as low as 3 to 4 per cent., but it would mean the destruction of almost half the total of our herds, which is unthinkable. To isolate affected animals is, without doubt, an excellent measure, practicable in large holdings, but impossible in the scanty buildings of the small and average farmer. Only one method seems to us to be worthy of practice and retention, and that is the vaccination of calves. The experiences of Calmette and Guérin, who have vaccinated very numerous calves with B.C.G., appear to us conclusive. Their researches have shown that the injection into the veins of young calves of a virulent culture of bovine bacilli causes no effect in vaccinated calves, whilst similar cultures injected into the veins of non-vaccinated calves cause acute disseminated tuberculosis. Certainly the method is not infallible, since some vaccinated calves may present very discrete tuberculous lesions, but lesions which are arrested in the glandular system, a premier advantage, since a closed tuberculosis, which is a cured and non-contagious form, is achieved. A few cases have been reported of vaccinated calves which have died from tuberculosis. In human and veterinary medicine there is nothing absolute. Vaccines and serums have diminished mortality, but unfortunately have not suppressed it.

Tests with B.C.G. have not only been made in France, but also in Austria. Belgium, Holland, Brazil, and in Canada in the State of Alberta. The researches conducted for six years in Canada seem conclusive, since vaccinated calves after a year in contact with tuberculous animals have only become affected in a very minute proportion. Vaccination, which is made subcutaneously, is easy and without danger. It ought to be done every year. The only criticism that one can make of this method is that vaccinated animals react to tuberculin. But it would not be difficult to identify these by marking the skin.

As a conclusion, one may assume that all calves should be vaccinated with B.C.G. This would be the most effective and certain means of bringing about the disappearance of bovine tuberculosis, or at any rate reducing the number of affected animals. This would also be a prophylactic measure against human tuberculosis.

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